ALTERNATE POWER SOURCES FOR CARS

Electronics NOW®

AUGUST 1998

Build a Super-Sensitive Heat Detector

Use it to find leaks, hot spots on circuit boards, and more

What's New in Solar Power

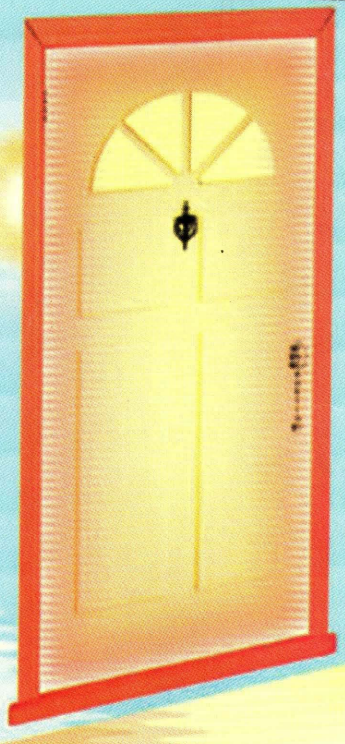
Here's why and how your next home might be powered by the Sun

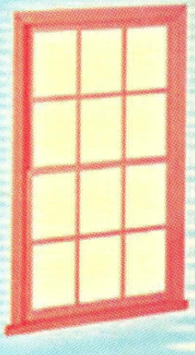
Build a Telephone Monitor and Controller

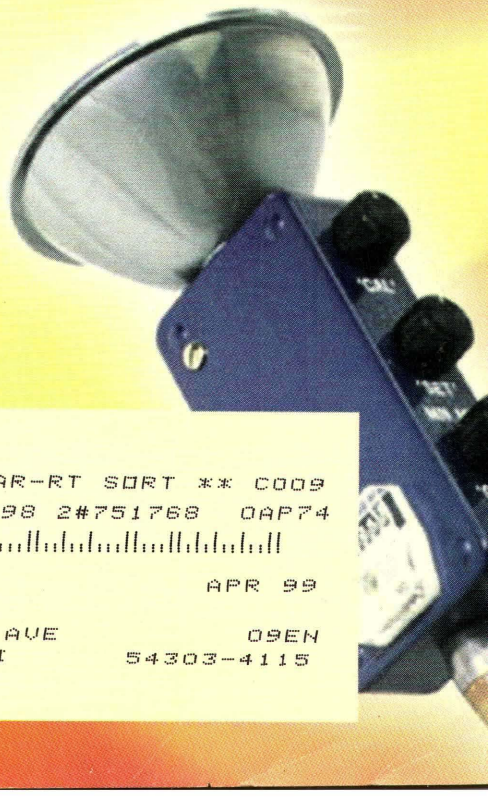
It keeps a log of every call and lets you use any telephone to control up to eight devices

Make Your Own Shunts

They make it easy to measure high current







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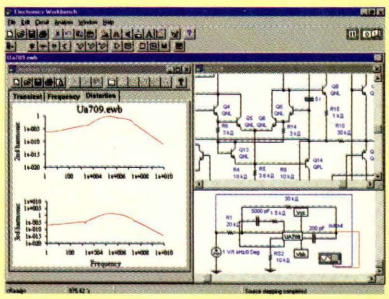

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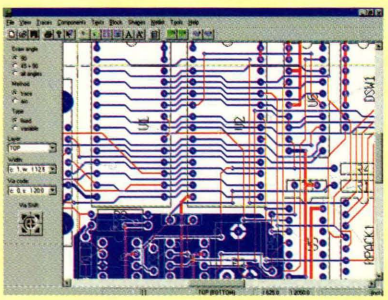

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Electronics NOW

Vol. 69 No. 8

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ON THE COVER

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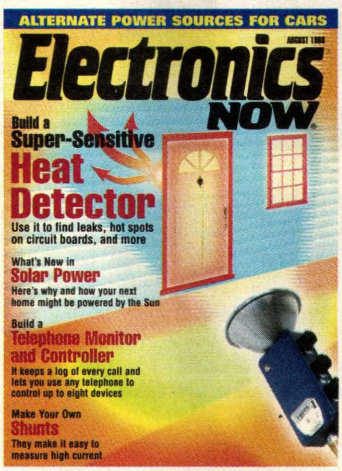
One look at your heating bill and you know that you have a problem. Despite all of the insulation and weather stripping you've installed, some of your expensive heat is clearly escaping, but from where? You could painstakingly search every inch of your work, but that could take hours, and you might still not find the weak spot. Now there's a better way—the Heat Detector. It will make quick work of the task as it can easily pinpoint even tiny temperature differences. It can also be used to find hot spots on circuit boards, car engines, and more. — *Skip Campisi*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Make Your Own
Shunts
They make it easy to measure high current

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Pinpointing lightning strikes in seconds, coming closer to sustainable nuclear fusion, using ultrasound to improve tire safety, and more.

51 MAKE YOUR OWN SHUNTS

They're nearly as accurate as the commercial units, but cost a lot less. — *Dean F. Poeth II, Ph.D., K8TM*

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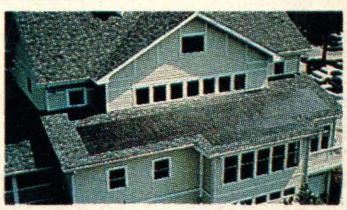

New technologies and initiatives are bringing down the cost of solar-power systems, and making them a lot more attractive to look at. — *Bill Siuru*

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AUGUST 1998

BUILD THIS

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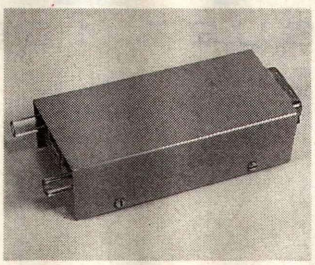
It keeps a running log of every call received or placed, and can also be used to control up to eight devices using any telephone.
— *Dave Dage*



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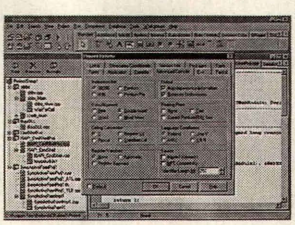

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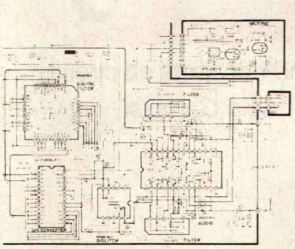

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Pentium® 133MHz Desktop System

- 16MB of RAM expandable to 128MB
- 256KB cache RAM
- 3.5" floppy drive, 1GB hard drive and 8X CD-ROM
- Combination sound and modem card

Monitor not included

- 2MB VGA graphics card on board upgradeable to 4MB
- Windows® 95, MS Money, MS Works
- Includes 104-key keyboard, remote control (mouse), 3.5" software and drivers and manual
- Size: 16.5"L x 16.0"W x 5.0"H
- Weight: 29.4 lbs.

Part No.	Description	Price
152338	133MHz Pentium® System	$599.95

Protolab 4.0 Software

A low-cost circuit design and simulation software.

- Includes 3.5" diskette and instructions
- System requirements: IBM PC 386; 4MB RAM, SVGA graphics, Windows® 3.1 or 95

Part No.	Description	Price
150682	Protolab 4.0 Software	$49.95

WAHL® Portable Heat Gun

- Portable and flameless heat
- Electronic ignition
- Temperatures up 1200°F (650°C)
- Size: 4.8"L x 0.9"W
- One-year warranty

Part No.	Product No.	Price
150691	Portable heat gun Special	$26.95

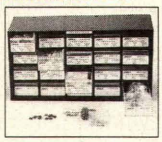
PICBasic Pro Compiler

Converts BASIC programs into hex or binary files for PIC microcontrollers.

- PC or compatibles
- For PIC16C6x, 62x, 7x, 8x, 12C67x,16C55x and 16C92x • One-year warranty
- Basic Stamp 1 & 2 compat. inst. set

Part No.	Description	Price
150543	PICBasic pro compiler	$249.95

Component Cabinet Kits

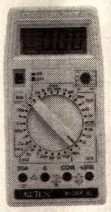


Kits include the most popular components with extra space for your customized expansion. Each kit includes a 20 drawer component cabinet.

More kits available – call for details!

Part No.	Description	Price
84953	330 pc. 7400 series IC kit	$129.95
84961	420 pc. 74LS series IC kit	119.95
84970	300 pc. CD4000 series IC kit	84.95
84988	385 pc. Linear series IC kit	159.95
108329	540 pc. 1/8 watt Resistor kit	29.95
81832	540 pc. 1/4 watt Resistor kit	28.95
107879	540 pc. 1/2 watt Resistor kit	32.95
108433	2200 pc. Electr. Hardware kit	39.95
81867	110 pc. Radial Capacitor kit	34.95
81859	320 pc. Ceramic Capacitor kit	29.95
81883	160 pc. Mylar Capacitor kit	34.95
81841	129 pc. Tantalum Capac. kit	49.95
82587	270 pc. Diode kit	39.95
82595	180 pc. Transistor kit	49.95

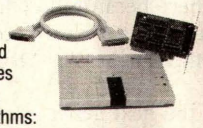
METEX® 3 1/2-Digit Digital Multimeter



- 3 1/2-digit LCD (.5" high digits)
- AC voltage: 200mV, 2V, 20V, 200V, 700V
- DC voltage: 200mV, 2V, 20V, 200V,1000V
- AC & DC current: 20µA, 200µA, 2mA, 20mA, 200mA, 2A, 20A
- Resistance: 200Ω, 2KΩ, 20KΩ, 200KΩ, 2MΩ, 20MΩ • Input impedance: 10MΩ
- Auto zeroing • One-year warranty

Part No.	Product No.	1-4	5-9
27115	M3800	$39.95	$35.95

1 Socket 16KB-8MB E(E)PROM Programmer



- Programs EPROMs, EEPROMs, and Flash memories
- Programming speeds/algorithms: normal, intelligent, and quick pulse

Part No.	Description	Price
132468	16Kb-8Mb E(E)PROM prog.	$199.95

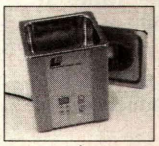
DATA I/O Universal 8KB-8MB EPROM Programmer

Parallel Port, DOS/Win 3.1®/Win® 95

- Programs 8 and 16-bit EPROMs up to 8MB, paged EPROMs, EEPROMs, serial EEPROMs (including 8-pin), flash devices, NVRAMs, bi-polar PROMs, PALs, GALs, PEELs, PALCEs, EPLDs
- Package supports DIPs up to 48-pin
- Robust memory and logic editing features

Part No.	Description	Price
145365	EPROM prog. Special	$949.95

Ultrasonic Steri-Cleaner



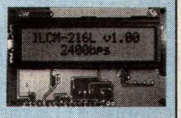
Cleans small submergible items with hard to reach corners!

- Operating frequency: 46kHz
- Tank capacity: 0.5 gallons • One-year warranty

Part No.	Description	1-4	5-9
149841	Steri-cleaner	$249.95	$224.95

Serial LCD Module

16 Characters x 2 Lines Integrated Display

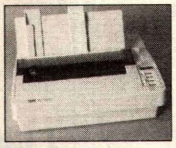


- EEPROM storage of settings, six custom characters
- One-year warranty
- Module size: 3.2"L x 2.0"W x 0.5"T

Part No.	Description	Price
150990	LCD module Special	$53.95

DEC Writer 95 Printer

Windows® 95 Compatible



- Impact dot-matrix with 24 wire print head
- Epson and IBM emulation character set
- 13 fonts built-in
- Includes sheet feeder, manual and drivers (Windows® 3.1 & 95) • Weight: 14.0 lbs.
- Size: 15.9"W x 12.6"D x 5.4"H

Part No.	Description	Price
151618	DEC writer 95.	$79.95

PARALLAX Basic Stamps

127693 130892

Basic Stamps are small computers using a variation of Basic, called PBASIC to control execution of many applications. The BS1-IC has 8 I/O lines, while the BS2-IC has 16 I/O lines which can be connected directly to buttons, LEDs, registers, and many other TTL level devices. • One-year warranty

Part No.	Description	Price
127693	Basic stamp BS1-IC	$34.95
130892	Basic stamp BS2-IC	49.95

Encyclopedia of Electronic Circuits on CD-ROM

Tab/McGraw-Hill Features 1,000 circuitry drawings from the 5-volume printed set. Fully searchable.

- Weight: 0.5 lbs.

Part No.	Description	1-4	5-9
130500	Encyclopedia	$99.95	$89.95

Flashing LED Sweetheart Kit

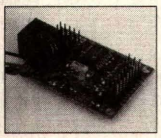
Shows a beating heart!

- Operating voltage: 8 to 15VDC
- Power consumption: 8mA
- Size: 2.5"L x 2.4"W x 1.2"H

Part No.	Description	1-4	5-9
147555	MK101 mini kit	$11.95	$10.95

Mini SSC II Module

(Serial Servo Controller)



- Controls 8 pulse-proportional servos
- Receives at 2400 or 9600 baud
- Modular input RJ11
- One year warranty
- Size: 1.9"L x 1.4"W

Part No.	Description	1-9	10-99
151001	SSC II module	$49.95	$44.95

EDWin NC (CAD/CAE) Software

The first truly seamlessly integrated suite of software running in all Windows® formats…simulation, schematics, and PCB design. Large start-up libraries.

Part No.	Description	1-4	5-9
141680	EDWin NC	$149.95	$134.95

Weller® 40-Watt Electronic Soldering Station

- 40 watts, 120V @ 60Hz
- Lighted on/off switch
- Adjustable power from 5 watts - 40 watts
- Temperature is electronically controlled from 350°F to 850°F • UL listed
- Includes ST3 1/8" screwdriver tip, soldering station, soldering handle and manual

Part No.	Description	Price
146595	40 watt soldering station	$44.95

69 Piece Professional Jumbo Tool Kit

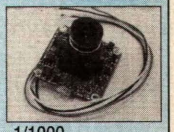
Comprehensive Kit for Field Technicians and Engineers!

- Size: 18.5"L x 13.8"W x 6.7"H • Wt.: 22.8 lbs.

Part No.	Description	Price
149024	Prof. tool kit Special	$219.95

Jameco Camera Board

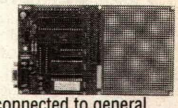
Sony Chipset



- EIA system 537(H) x 505(V)
- Composite output with 420 line resolution
- Shutter speed: 1/60 - 1/1000
- Requires 12V power source (not included) • One-year warranty
- Size: 1.3"L x 1.3"W x 1.0"H

Part No.	Description	Price
150931	Camera board Special	$74.95

8031 Embedded Applications Proto PC Board



- 32KB of SRAM
- 32KB of monitor EPROM
- 8031 CPU
- 14 screw-type terminal blocks connected to general purpose digital input/output ports
- 40-pin header for all system signals
- Two 23-pin headers for demultiplexed data, address, control, and I/O signals
- Size: 7.0"L x 4.0"W • One-year warranty

Part No.	Description	Price
119546	Prototype PC board	$99.95

Jameco Solderless Breadboards

20773

- Low static plastic body – CMOS safe
- Nickel plated clips designed to withstand up to 5,000 insertion cycles

Part Number	Contact Points	Size L x W	1-9	10-49
94457	100	6.5 x 0.4	$2.49	$2.25
20600	400	3.3 x 2.1	4.95	4.49
136901	1,600	5.5 x 2.3	21.95	19.95
20669	630	6.5 x 1.4	5.49	4.95
20722	830	6.5 x 2.1	7.95	6.95
20757	1,360	6.5 x 3.1	11.95	10.95
20773	1,660	6.5 x 4.3	17.95	15.95
20790	2,390	6.9 x 5.8	22.95	20.49
20811	3,220	7.3 x 7.5	30.95	27.95

Robots, Androids and Animatrons (1997)

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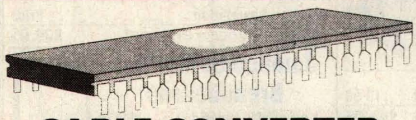

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EDITORIAL

I Object

Before I start, let me make one thing clear: I am not a real big fan of Microsoft. So, you can imagine how surprised I am to find myself defending them in this space. Then again, since I am defending them against the government, well . . .

Our society is based on the principle of free enterprise. Yes, Microsoft is in the powerful position it is in today thanks in part to shrewd, aggressive, and perhaps ruthless marketing. It is also there because they have devised an operating system that fills the needs of most users better or more economically than their current competitors (Unix, Linux, OS/2, and Macintosh). Maybe someday that will change.

Win98 is slated to be the next generation in their operating system family. Not so much a revolutionary change, it is more of an updating and tweaking of Win95. One of the critical improvements was the integration of the already available Active Desktop. That feature provides, among other things, a seamless integration between a user's PC desktop and the Internet, making using the resources available on the Internet an easier and more intuitive operation. Of course, to do that, the desktop needs a browser component. Naturally, Microsoft chose to use its own Internet Explorer (IE) browser for that.

At least that was the plan before the government stepped in. As this is being written, the Justice Department along with a slew of State Attorney Generals have filed suit accusing Microsoft of violating anti-trust laws and seeking to block the release of Win98 unless either Internet Explorer is deleted from it or Netscape's browser is bundled with it to give consumers a choice. For obvious reasons, neither choice is acceptable to Microsoft.

The government means well, but as usual when it comes to technology, they are misguided. There was a monopoly in the browser market—it belonged to Netscape prior to Microsoft's entry into the field. Even today, Netscape by the government's own figures, still has 60% of the market. And the presence of IE in the operating system does not stop users from using Netscape if they wish. Its presence is well advertised on the Net, and getting a copy is easy and free (although the latter was not the case prior to the introduction of IE).

Other points are equally weak. For example, the suit makes a big deal about the "Channel" bar that highlights content providers with ties to Microsoft. But you know what, Netscape comes with Netcaster, which is pretty much the same thing, with the same types of problems. Fortunately, disabling such "features" is easy enough, if you wish.

What annoys me here is that the suit seems to be the government's way of saying that computer users are dolts, unable to use anything other than the tools put in front of them. Just because it comes bundled with your system, you are under no obligation to use IE, or any other bundled app for that matter. Of course, if you have any degree of computer literacy, you already know that. If not, I guess you sue.

Carl Laron

Carl Laron
Editor

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LETTERS

SEND YOUR COMMENTS TO THE EDITORS OF ELECTRONICS NOW MAGAZINE

Oooops!

I was examining the schematic and PC board in the article "Build an AM Transmitter" (June, 1998), and believe I have uncovered a problem. In the schematic, resistor R45 is shown grounded. However, on the board, it is shown wired to the cathode of D8. Which is correct?

JAY CRASWELL
Jordan, MN

The PC board is correct. In preparing the art for publication, the connection from the bottom of R45 was drawn too long. It actually terminates at the line above the one shown, which goes to D8 as per the board. We are sorry for any confusion that might have been caused—Editor

Where Are the Indexes?

Hello. I have been a long time subscriber to your magazine. I noticed that, unlike recent years, you did not publish an Annual Index. I do recall reading somewhere that you have moved the indexes to your Internet site, but I was unable to locate them. Can you help?

D. SMITHSON
via e-mail

Sure: A searchable index of all articles that have appeared in ***Electronics Now*** *(and* ***Popular Electronics)*** *since September 1994 is available on the Gernsback Publications Web site (www.gernsback.com). You can get to it off the main* ***Electronics Now*** *page on that site. If you want to go directly to the index, the URL for the search page (no-frames version) is www.gernsback.com/noframe/en/html/ENaisearch_nf.html—Editor*

Still Disaffected

I read with considerable annoyance your June 1998 editorial: "The Object of Disaffection," which you say is based on your receiving letters, phone calls, and e-mail regarding the lack of source code for microcontrollers. I presume that I am one of the people you are referring to in the editorial. However, my complaints have never been directly referencing the availability of source code, instead my complaints have been about the impossibility of building the projects without buying the kits advertised by your authors. Not only has the lack of source code for microcontrollers been a problem, but also code (object, source or otherwise) for PC interfaces and PLDs. None of these points were addressed in your editorial.

In your editorial, you say "While our policy is to insist that any software required to make a project operate as described be made available, which in the case of microcontrollers means the object code as a minimum...". While not ideal, this would be acceptable, but I do not see any evidence that this is the case.

I've just checked your web page and for **Electronics Now**, the project code on the web page was last updated on September 16, 1997 and for **Popular Electronics,** the project code was last updated on July 25, 1997. This means that any readers who are unable or unwilling to buy the kits that are advertised in your magazine, cannot reproduce the projects you've presented in your magazine, even though the authors have been paid by you (and us, indirectly) to release the information required to build the projects. For example, in a June 1998 article entitled "Add a Video Trigger to your Oscilloscope", you publish bare board foil patterns, but don't give PLD information or microcontroller object code. This is a very interesting project that, as far as I can see, the reader cannot reproduce without buying the kit from the author!

This experience has been quite frustrating for me as I do not feel like my concerns have been adequately addressed.

MICHAEL PREDKO
via e-mail

As per the article, the required file, vidtrig.zip, is posted on the ftp site. However, I believe I know what has happened here. Shortly after the ftp site was set up, readme files were posted that listed the available articles in each directory. Unfortunately, though new files were being uploaded every month, the readme files were not being updated. Though this is the first anyone has complained, at least to us, we do need to get them up-to-date, and it will be done right away. Please accept our apologies for any confusion that was caused by this oversight.

On another note: We understand why many readers object to purchasing kits or parts solely from one source. Because of that, we insist that authors provide sources for parts other than the kit/part supplier mentioned in the article, and provide all software required to make a project function as described. On the other hand, our experience has been that oft times, the cost of the kits is less than what a typical hobbyist would need to spend to acquire the parts on his or her own, especially when you consider the high minimum orders many parts distributors require these days. Yes, if you have access to a large reserve of parts, "rolling your own" can save you a bit of money, but that is not always the case, and even less so if all parts must be obtained new through traditional channels.

Anyway, the point is that whether you want to buy a kit (when offered) or go it alone is up to you. We do our best to give you the tools you need to succeed regardless of the path you choose.—Editor EN

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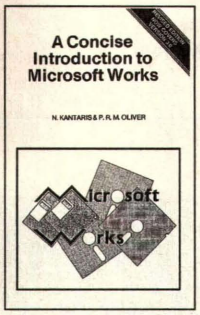

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☐ **BP298–Concise Intro to the Macintosh System and Finder $7.50.** Although the Mac's WIMP user interface is designed to be easy to use, much of it only becomes clear when it is explained in simple terms. The book explains: The System and Finder, what they are and what they do; how to use the System and Finder to manipulate disks, files and folders; configuring and printing files from the Finder; getting the most from the system utility programs; and running MultiFinder.

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☐ **BP316–Practical Electric Design Data $10.95.** A builder's bargain book–a comprehensive ready-reference manual for electronic enthusiasts with over 150 practical circuits. It covers the main kinds of components (from pig-tail leads to surface mount), pin-outs, specs and type selection. Basic units are defined and most used formulae explained. Five additional sections are devoted to circuit design, covering analog, digital, display, radio and power supply circuits.

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Q & A

READERS' QUESTIONS, EDITORS' ANSWERS

Pinball Wizard Correction

Contrary to what we said in the May 1998 installment of "Q&A," the fine folks at Two Bit Score, Austin, Texas, do NOT repair, or supply parts for, Gottlieb pinball games. They do service most of the other leading makes. For more information see their web site at www.twobit.com. If anyone knows of a supplier of Gottlieb parts, do please let us know.

Dawn Simulator

Q *I would like to have a 120-volt AC circuit controlled by a clock radio so that when the clock switches the radio on, a 100-watt bulb will start very dim and brighten over a period of about 30 seconds. — F. P., Orland Park, IL*

A What you want is called a "dawn simulator" and is sometimes used to treat sleep disorders; it's a very gentle, natural way to wake a person up. Some dawn simulators take as long as 30 minutes (not 30 seconds) to bring the lights up to full brightness.

As you know, a light dimmer works by cutting off part of each AC cycle. This is done by triggering a Triac (AC switch) after part of each cycle has already passed by. The best way to build a dawn simulator would be to use a microcontroller to compute the exact time delay during each cycle, changing it slowly over a period of minutes. If there's sufficient interest, we might develop this as a construction project later; it would provide very smooth, reliable operation.

In the meantime, Fig. 1 shows an all-analog circuit that you can build. It's a modernized version of a circuit originally published by General Electric that used a unijunction transistor and a pulse transformer, both of which are hard to get nowadays.

Diodes D1-D4, resistor R1, and diode D5 produce a pulsating DC waveform clamped to 15 volts; almost a square wave. From that, the circuit derives two more waveforms, a sawtooth across C1 and a slowly rising voltage across C2. Those are combined, amplified by Q1 and Q2, and then used to control the Triac (TR1) through an optocoupler.

Switch S1 lets you start the timing cycle over again—a necessity while you are testing the circuit. The circuit is somewhat tricky, and you should breadboard it before building the final version. Adjust R4 so that the light bulb just goes off when S1 is pressed; you'll find that R4 affects the behavior of the circuit quite a bit. Change C2 to change the timing period; for a true dawn simulator, you may want to make C2 as large as 3200 mF. Use a smaller value while experimenting so you don't have to wait half an hour to see what's going to happen.

Most of the other parts aren't critical.

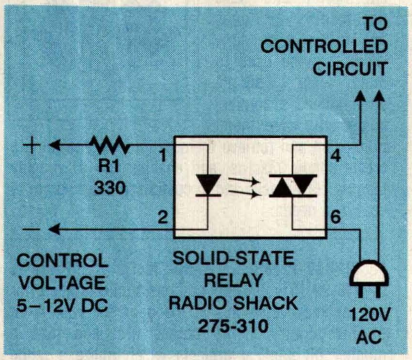

FIG. 2—USE THIS APPROACH TO INTERFACE the dawn simulator with a clock radio. The leads marked "Control Voltage" go across the capacitor in the radio circuit as described (see text), while the leads marked "To Controlled Circuit" go to the AC input of the simulator.

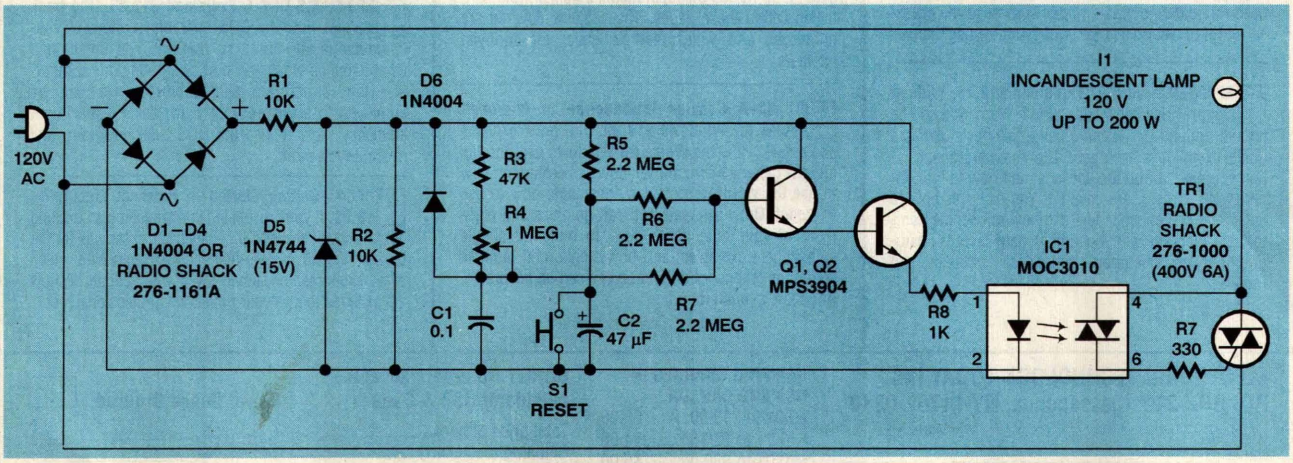

FIG.1—WHILE THE BEST APPROACH WOULD BE TO USE A MICROPROCESSOR, this all-analog circuit will fill the bill. It is a modernized version of a "dawn-simulator" circuit originally published by General Electric.

You can use any Triac with suitable ratings. For D1–D4, you can use four 1N4004s or one bridge rectifier (Radio Shack 276-1161A or similar). Check the temperature of the Triac and of R7 while the circuit is operating (but beware of high voltage); use a heat sink on the Triac and/or a higher-wattage resistor (as appropriate) if they get hot.

A word of caution: This circuit can generate appreciable radio-frequency interference (RFI). Keep the light bulb close to TR1, and if you have RFI problems, put a 100-millihenry RF choke in series with the Triac and light bulb.

Now for the clock-radio interface. What you'll need to do is find a DC supply voltage inside the radio that is switched by the electronic clock circuit. That will probably be between 6 and 12 volts; look for it across a large electrolytic capacitor near the radio circuitry. Some exploration with a voltmeter will be required. Once you've found a switched voltage source, connect it to a solid-state relay as shown in Fig. 2. You can then use it to control 120-volt AC loads.

Changing Voltage

Q *We have a Sony AM/FM clock radio that runs on 120-volts AC, 60 Hz. How could we use this on 220 volts, 60 Hz, outside the United States? What kind of dropping resistance could be incorporated into the circuit? We tried a line-voltage converter from Radio Shack, but it didn't work. — G. J. S., Newhall, CA*

A If the foreign AC power is actually 220-240 volts, 60 Hz (not 50 Hz), all you need is a transformer. A voltage-dropping resistor wouldn't be satisfactory because the voltage drop depends on the amount of current being drawn through it, which depends on how loud the radio is playing, among other things.

Radio Shack's 273-1401 voltage converter or any comparable transformer should do the job. This kind of voltage converter is relatively heavy because of its iron core and is rated to handle only 50 watts or so. Don't use the other kind of converter, which is lightweight and handles hundreds of watts; it doesn't produce normal AC output. Instead, it trims away part of the AC waveform like a light dimmer (see "Dawn Simulator" elsewhere in this column) and is suitable only for lights, heating elements, and some types of motors.

Also, double-check that the foreign power is 60 Hz, not 50 Hz. British and European power is 220 to 240 volts, 50 Hz, and transformers change the voltage but not the frequency. Also, check the label on the radio; if it says "50-60 Hz" then both frequencies are OK. Otherwise, there is no cheap way to change the frequency of the AC power; it's cheaper to get another radio.

Bulk Tape Eraser

Q *I want to build an electromagnet to erase VCR tapes. Low-priced bulk erasers mostly just muddy the tape and you have to take a nap between erasures to let the magnet cool. A commercial unit that develops 3000 Gauss costs over $350, but I can't afford that investment. I could wind my own magnet if I had the specifications. — R. C., Meridian, MS*

A Before giving up on low-priced bulk erasers, make sure you're using them as effectively as possible. The tape has to get very close to the magnet in order to be erased. Consult the instructions to find out how to position the eraser and the tape. Erasing a tape should take only a few seconds and should not overheat the magnet. After erasing, be sure to move the magnet well away from the tape before turning it off to avoid re-magnetizing it with the pulse that occurs at turn-off.

Next, experiment. Could you combine two cheap erasers to make a more effective one? Another cheap way to get strong electromagnets is to take apart junked electric motors. We once made a small, effective demagnetizer by removing the rotor from a phonograph motor; perhaps you could do the same thing with a larger induction motor to make a tape eraser. Be sure to include a light bulb in series with the electromagnet in order to limit the current; you can get more current by changing to a higher-wattage bulb.

Powering Probescope From Computer

Q *I use a RadioShack Probescope, which is a hand-held digital oscilloscope that inter-*

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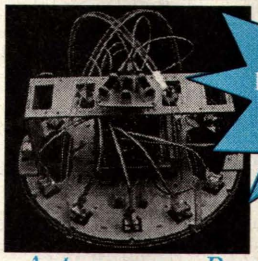

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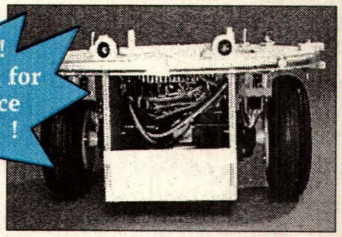

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On the Internet: See our Web site at http://www.gernsback.com for information and files relating to our magazines (**Electronics Now** and **Popular Electronics**) and links to other useful sites.

To discuss electronics with your fellow enthusiasts, visit the newsgroups sci.electronics.repair, sci.electronics.components, sci.electronics.design, and rec.radio.amateur.homebrew. "For sale" messages are permitted only in rec.radio.swap and misc.industry.electronics.marketplace.

Many electronic component manufacturers have Web pages; see the directory at http://www.hitex.com/chipdir/, or try addresses such as http://www.ti.com and http://www.motorola.com (substituting any company's name or abbreviation as appropriate). Many IC data sheets can be viewed online. Extensive information about how to repair consumer electronic devices and computers can be found at www.repairfaq.org.

Books: Several good introductory electronics books are available at RadioShack, including one on building power supplies.

An excellent general electronics textbook is *The Art of Electronics*, by Paul Horowitz and Winfield Hill, available from the publisher (Cambridge University Press, 1-800-872-7423) or on special order through any bookstore. Its 1125 pages are full of information on how to build working circuits, with a minimum of mathematics.

Also indispensable is *The ARRL Handbook for Radio Amateurs*, comprising 1000 pages of theory, radio circuits, and ready-to-build projects, available from the American Radio Relay League, Newington, CT 06111, and from ham-radio equipment dealers.

Copies of past articles: Copies of past articles in **Electronics Now** and **Popular Electronics** (post 1993 only) are available from our Claggk, Inc., Reprint Department, P.O Box 4099, Farmingdale, NY 11735; Tel: 516-293-3751.

Electronics Now and many other magazines are indexed in the *Reader's Guide to Periodical Literature,* available at your public library. Copies of articles in other magazines can be obtained through your public library's interlibrary loan service; expect to pay about 30 cents a page.

Service manuals: Manuals for radios, TVs, VCRs, audio equipment, and some computers are available from Howard W. Sams & Co., Indianapolis, IN 46214 (1-800-428-7267). The free Sams catalog also lists addresses of manufacturers and parts dealers. Even if an item isn't listed in the catalog, it pays to call Sams; they may have a schematic on file which they can copy for you.

Manuals for older test equipment and ham radio gear are available from Hi Manuals, PO Box 802, Council Bluffs, IA 51502, and Manuals Plus, PO Box 549, Tooele, UT 84074.

Replacement semiconductors: Replacement transistors, ICs, and other semiconductors, marketed by Philips ECG, NTE, and Thomson (SK), are available through most parts dealers (including RadioShack on special order). The ECG, NTE, and SK lines contain a few hundred parts that substitute for many thousands of others; a directory (supplied as a large book and on diskette) tells you which one to use. NTE numbers usually match ECG; SK numbers are different.

Remember that the "2S" in a Japanese type number is usually omitted; a transistor marked D945 is actually a 2SD945.

Hamfests (swap meets) and local organizations: These can be located by writing to the American Radio Relay League , Newington, CT 06111; (http://www.arrl.org). A hamfest is an excellent place to pick up used test equipment, older parts, and other items at bargain prices, as well as to meet your fellow electronics enthusiasts—both amateur and professional.

faces with a personal computer. My only problem is how to power it. It requires 9 to 13 volts DC and draws 12 to 85 mA. Sometimes, but not always, I can obtain power from the circuit under test.

After seeing the Pager Decoder featured in the 1997 issue of ***Electronics Now****, I'm wondering if the Probescope can be powered from the computer's serial port in the same way that that project was. Is this practical? — G. O., Roseville, MN*

A Sadly, the answer is no. The data lines of a serial port can easily provide a few mA to drive a CMOS circuit or even a single LED, but 12 to 85 mA is more than they can deliver. You can, however, power the Probescope from the 12-volt (yellow and black) wires of an unused disk-drive power connector inside your PC. If you frequently use your PC for electronic experiments, you may want to rig up external connections to its power supply so you can borrow power for experimental circuits. Use 0.5-amp fuses for protection.

Calling Benchmarq . . .

Q *I have a Sears Craftsman cordless drill whose charger uses a Benchmarq BQ2004PN integrated circuit. Sears won't give me any information on this IC. I would think they would be interested in selling the parts for their tools or helping me find them. Can anyone tell me how to find this part or a substitute? — J. W. B., Greenfield, OH*

A The drill is almost certainly made, or at least designed, for Sears by another company, and Sears probably handles the entire charger as a single replacement part.

However, the IC maker, Benchmarq Microelectronics, is easy to locate. Benchmarq makes a variety of high-performance battery-charger ICs. You can write to them at 17919 Waterview Parkway, Dallas, TX 75252, and request a data sheet, or see product data on the Web at www.benchmarq.com.

Benchmarq chips are sold by distributors; one of them is Marshall Electronics, 89320 Telstar Avenue, El Monte, CA 91731; Web: www.marshall.com; Tel: 800-833-9910. Marshall takes orders 24 hours a day.

Looking for MM5369

Q *In your January 1998 issue you recommended a National Semiconductor MM5368 or MM5369 IC for use in a precision pulse generator. Since the summer of 1997, National Semiconductor no longer makes these chips, and I haven't been able to find any equivalents. Do you know of any alternatives or any way of building an equivalent circuit from other chips? — A. H., Mountain View, CA*

A These chips generate precise 60-Hz squarewaves from, respectively, a 32.768-kHz watch crystal and a 3.58-MHz color TV crystal. The MM5368 is admittedly a rare beast, but it will be a while before the MM5369AA/N disappears from the hobbyist market. As this is written, it is still in stock at Jameco, 1355 Shoreway Road, Belmont, CA 94002; Web: www.jameco.com Tel: 800-831-4242 (where it is listed as "part no. 26104") and at Advanced Computer Products, 1310 E. Edinger Ave., Santa

Ana, CA 92705; Tel: 714-558-8822. You can get it in larger quantities ($100 minimum) from Ambassador Components, 1747-6 Veterans Hwy., Islandia, NY 11722; e-mail: sales@ambass.com; Tel: 516-234-5299.

A more modern solution to the same problem would be to program a microcontroller to produce a squarewave at the desired frequency. The new 8-pin PIC microcontrollers (PIC12C508 and PIC12C509) are especially compact and convenient. Or use a CD4060 14-stage binary counter chip, which includes gates that can be used as an on-board crystal oscillator, with a 0.983040-MHz crystal to generate 60 Hz. See the CD4060 data sheet (available online at www.nsc.com) for a suggested circuit. You can get that crystal custom-made for about $30 by International Crystal Mfg., 10 N. Lee Avenue, Oklahoma City, OK 73126; Tel: 800-725-1426, and while you wait for it to arrive, you can use a cheap 1-MHz microprocessor crystal for testing; that will give you 61.035 Hz.

Clock That Sets Itself

Q *I have seen digital clocks advertised that receive time signals from the National Institute of Standards and Technology and will keep the correct time automatically. I have been trying to find a schematic for such a clock without success. Do you know where I can obtain one? — L. J., Florissant, MO*

A You can still get a manual for the now-discontinued Heathkit "Most Accurate Clock" (model GC-1000-H) from Heath Company, Tel: 616-925-5899 (they sell manuals only by phone). Bear in mind that any clock of this type contains a programmed microcontroller that the schematic will not enable you to duplicate. More modern clocks that tune in NIST signals are available from Comtrad Industries, 2820 Waterford Lake Drive, Suite 102, Midlothian, VA 23113; Tel: 800-992-2966.

The NIST signals are delivered by shortwave radio from stations WWV, in Colorado, and WWVH, in Hawaii. Reception varies quite a bit from place to place, and nowadays most people who need accurate time signals prefer to use a GPS satellite receiver. GPS receivers display the time of day and can be interfaced directly to computers as described in this column (see January 1998, pp. 11-12). Because a GPS receiver contains several very specialized ICs and works at ultra-high frequencies, it's not practical to build your own; instead, treat the entire receiver as a unit that can be interfaced to other projects.

Two Stereo Questions

Q *I am repairing a Sansui QRX-3300 4-channel stereo. I need a schematic and service manual. Where can I get them? I would be willing to pay a fair sum.*

Also, now that stereos have remote controls, why doesn't the remote control include a speaker A/B switch? Is there a simple way to add one? — R. S. N., Marathon, FL

A Your best and most likely source would be the manufacturer, Sansui Electronics, 17150 S. Margay Avenue, Carson, CA 90746; Tel: 310-604-7600.

As for your second question, remote controls normally switch the low-level signals at the input of the amplifier. This switching is done with CMOS digital and analog ICs. A speaker A/B switch switches the output of the amplifier at the speaker connections; that's a high-level signal and no additional resistance is tolerable (obviously, even 1 extra ohm would affect the output from a 4-ohm speaker). For this reason, an A/B switch has to be mechanical or electromechanical. If you wanted to add one, you'd have to use relays, which cost more money and take up considerably more space than ICs.

Writing to Q&A

As always, we welcome your questions. The most interesting ones are answered in print. Please be sure to include plenty of background information (we'll shorten your letter for publication) and give your full name and address. *If you are asking about a circuit, please include a complete diagram.* Write to "Q&A," **Electronics Now** Magazine, 500 Bi-County Blvd., Farmingdale, NY 11735. Due to the volume of mail, we regret that we cannot give personal replies. EN

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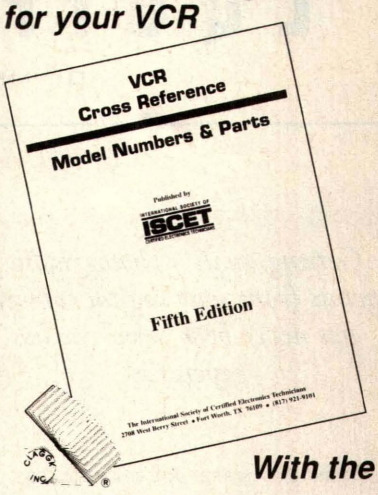

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This 119-page reference contains both model and part-number cross-references updated to include 1994 units.

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EQUIPMENT REPORT

OLYMPUS P-300 PERSONAL PHOTO PRINTER

Getting quality photographic prints from your digital camera has never been easier, or less expensive.

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Until recently, digital photography has always been a promising technology, but one that was full of compromises. For one thing, the digital cameras themselves have been quite expensive, and the only ones that were even close to being affordable for the casual user offered relatively low resolutions—usually a maximum of 640 × 480.

But that is changing. Cameras having resolutions of 1024 × 768 and higher are now available at prices of around $600, and sometimes lower. And while they still do not quite measure up to well-focused photographs made with conventional film, images with a resolution of 1024 × 768 can be made into photo-album size prints that look incredibly sharp.

Which brings us to another problem with digital photography: producing paper prints from electronic images. Let's face it: most people still keep their favorite photos in albums and don't want to have to turn on a computer to see them. There are services that will take the output from your camera and produce finished prints, but most are not inexpensive, and it can take a while to get your prints back. Plus, most require that you have online access of some sort to upload the digital images to them.

More popular is using an ink-jet printer to produce prints, but there are problems here, too. For one, only some ink jets are capable of producing prints of acceptable quality. And even those usually require the use of special "photo" ink cartridges and paper for best results. Further, both the paper and the ink are relatively pricey, and printing photos uses a lot of ink and can take a long time to do.

Now, however, there's a better alternative. It's a neat little printer from Olympus whose output rivals 35-millimeter prints, and it is much better than the photos produced by instant cameras.

Olympus P-300

The P-300 is a 300 dpi, photo-quality dye-sublimation printer that produces continuous color tones. The P-300's output is equivalent to that of a 2400-dpi ink-jet printer. Images are printed on 4- by 5.5-inch glossy sheets in true 24-bit color (16.7 million possible colors). It takes about 100 seconds to make a print. Images can come from scanners, digital cameras, the Internet, and so on—as long as they're digital, you can print them on the P-300.

Olympus has equipped the P-300 with a parallel port for connecting to PCs and a serial Macintosh port for connecting to Macs. You'll need at least a 486 PC running Windows 3.1x or Windows 95, or a Mac with a 68040 PCU or later and Mac OS 7x or later. A CD-ROM drive is also required. You can use whatever software you like, such as Adobe Photoshop, to print to the P-300. You simply have to set the print size to that of the P-300's paper.

And if you happen to have an Olympus digital camera, you don't even need a computer to create prints. Though the procedure differs slightly from camera to camera, any Olympus digital camera can be connected directly to the printer and prints can be made right from it. The P-300 will not work directly with digital cameras from other manufacturers.

The P-300 measures $10^{7}/_{8}$ inches front to back with its tiny paper tray attached and is $2^{5}/_{8}$ high by $9^{5}/_{8}$ inches wide. It weighs 5 pounds 8 ounces. It prints 3.5- × 4.5-inch images on 4- × 5.5-inch sheets. The paper tray holds 30 sheets, and a thumb wheel on the tray lets you set the number of prints you want of the same image.

The P-300 requires a special dye-sublimation ribbon that looks like cellophane reeled up in a film cartridge. The ribbon cartridge, good for 60 prints, slides into the side of the printer. The printer uses heat to fuse color from the ribbon onto the print sheets in continuous tones.

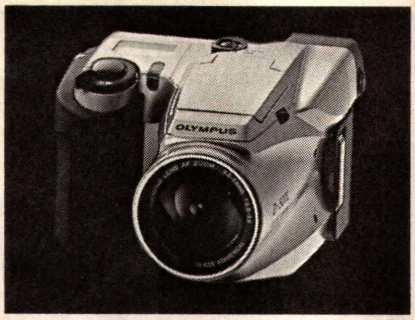
Aside from the 4- × 5.5-inch glossy photo paper, Olympus also offers sticker-label photo paper and miniature sticker-photo labels, 16 to a sheet, which are great for sealing envelopes and the like.

Hooking It Up

The P-300 was tested both connected to a PC and connected directly to an Olympus camera. The printer is easy to unpack from its carton because of its small size. There is very little to set up: You simply insert the paper tray into the front of the printer, load the glossy photo paper and ribbon cartridge, plug the printer into an outlet, and you're off.

Connecting the P-300 to a PC is easy. You simply connect it with a parallel cable and load the drivers using the "Add New Printer" icon in the Windows control panel. Then use whatever graphics program you have available. One benefit to using a computer is that images can be retouched and enhanced before printing, which, of course, is not possible when printing directly from a camera.

The perfect complement to the P-300 printer is the Olympus D-500L



THE OLYMPUS D-500L digital camera is the perfect companion to the P-300 photo printer. The printer can also print directly from any other Olympus digital camera, or from any digital camera if a computer is used.

Digital Camera. It has a maximum resolution of 1024 × 768, a 3× zoom, a back panel color LCD for reviewing images, three levels of compression, a serial port for connecting to computers, and a parallel port for connecting directly to the P-300 printer.

A special cable connects the D-500L camera to the P-300 printer. After the two units are connected to each other they can be turned on. With the camera set to play back its stored images, they can be previewed on the screen on the back of the camera. Whichever image is displayed on the camera can be printed at the touch of a print button on the D-500L camera. With some other Olympus digital cameras, a "Direct Print" button on the P-300 is used, though it has no function when the printer is connected to the D-500L. Once the print button (on either the camera or the printer, depending on the setup) is pressed, the printer starts whirring and about a minute and a half later, a glossy color print pops out. Multiple prints can be made by setting a dial on the side of the paper tray.

The P-300 costs $399, and it comes with a 10-print paper and ribbon kit. Additional 60-print paper/ribbon kits sell for $39.95, and are available wherever the printer is sold. The D-500L has a suggested retail price of $799, though there are much less expensive Olympus cameras that will print to the P-300 (and don't forget that the unit will work with just about any digital camera). For more information on the P-300, contact the manufacturer directly (Olympus America Inc., Digital & Imaging Systems Group, Two Corporate Center Dr., Melville, NY 11747; Tel: 800-347-4027; Web: www.olympus.com), or circle 15 on the Free Information Card. EN

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BY JEFF HOLTZMAN
COMPUTER EDITOR

XML Update, C++ Builder, and More

I GAVE A PRETTY TIGHT OVERVIEW OF XML LAST MONTH, AND DIDN'T PROVIDE ANY REFERENCES FOR FURTHER STUDY. I'LL TRY TO CORRECT THAT DEFICIENCY NOW; IN ADDITION, I'VE SINCE RUN ACROSS A FEW MORE RESOURCES THAT CAN HELP flesh out the details.

The canonical source is the XML spec (Extensible Markup Language (XML) 1.0, W3C Recommendation 10-February-1998), available at the World Wide Web Consortium www.w3.org. Counting appendices, the spec is only 32 pages long. An easy read, right? Guess again. Without a good background in formal language theory, it will probably seem like Greek. Even with a good background, it's difficult, lacking in examples, and inconsistent in treatment depth across various areas.

There are several FAQ documents floating around. The best is "The XML FAQ," available at www.ucc.ie/xml/. Microsoft, ArborText, and other interested commercial concerns have their own FAQs that tend to be interesting as indicators of how the companies interpret and plan to extend XML. For example, Microsoft's FAQ discusses the concept of schemas; quoting directly from the 1/8/98 document (the word schema appears nowhere in the 2/10/98 W3C Recommendation):

"Schemas combine concepts from DTDs, relational databases, and object-oriented design. Schemas can describe the structure of XML documents, databases, directed-labeled-graphs, and other similar organizations of data. Schemas supply additional semantic information to documents, and contain new facilities such as data types, inheritance, and extensibility that are not available in DTDs. Schemas use the same syntax as XML documents."

Microsoft's FAQ also briefly mentions Channel Definition Format (CDF), the company's XML-based "push" technology that provides a way for web servers to deliver advertising and other goodies to your browser; Open Software Description (OSD), an XML format to aid software distribution; Open Financial Exchange (OFX), a format for communicating with financial institutions; and Resource Description Format (RDF), which (to quote again) *"allows for generalized searching of information without application-specific rules... [and] ... allows a complementary view of data through graphs and nodes, rather than through a structured tree, which the current XML technology enables."*

Of all the technologies mentioned in the previous paragraph, RDF sounds most interesting to me, with its hint of a hyperlink modeling scheme. I wouldn't be surprised to see RDF end up as the core of the Windows Help System someday. The Schema concept is also tantalizing.

RESOURCES

Using HTML 4
Lois Patterson, *et al.*
Que 1998
ISBN: 0-7897-1450-7

Presenting XML
Richard Light
Sams1997
ISBN: 1-57521-334-6

XML Books

Chapter 16 of *Using HTML 4* contains a pretty good overview of XML, along with a few very basic yet practical examples. I wouldn't buy the book just for that chapter, but if you do any web development, it would be a reasonable investment.

The most detailed, in-depth treatment I've found so far is *Presenting XML*, by Richard Light. One thing I don't like about the book is Light's frequently sloppy language. To me it seems unforgivable that a book about a formal language is so careless in its description of that language. It's great to try to avoid being terse (like the spec) or pedantic, but the cure seems worse than the disease in this case.

Anyway, if you read carefully and cross-reference the spec, you can learn a lot from *Presenting XML*. The spec itself is well dissected. There are lots of examples, including a chapter on converting HTML to XML, another on available XML software, and a good bibliography.

C++ Builder 3.0

In today's business world, can you create documents or spreadsheets in anything but a Microsoft product? That's debatable. But there's no question that you can create programs without supporting the MS habit. A few years ago, lots of naysayers predicted Borland's imminent decline; in case you haven't noticed, Borland is back, and with a vengeance.

Recent publicity from the company trumpets four consecutive quarters of revenue growth and three of profitability. The last three product introductions

(Continued on page 25)

Prototype

The National Lightning Detection Network

Whether it involves building new electric-power distribution lines, forecasting weather, planning military-training exercises, or establishing responsibility for damage, detailed information on lightning-strike activity can be important. That information—both real time and historical—is now readily available thanks to the National Lightning Detection Network (NLDN). The NLDN, owned and operated by Global Atmospherics, Inc. (GAI) in Tucson, AZ, is the largest and most sophisticated lightning-detection and -location system in the world.

The NLDN consists of ground-based sensing stations that detect cloud-to-ground lightning activity across the continental U.S. The sensors instantaneously detect the electromagnetic signal given off when lightning strikes the ground. Sophisticated techniques are used to differentiate between lightning strikes and background noise. The individual sensors transmit the lightning data via a communications satellite to central ground stations. These, in turn, send the information to the Network Control Center (NCC) in Tucson.

Using data from two or more sensors, computers at the NCC determine the strike location to within an average accuracy of 500 meters (1640 feet). That high level of accuracy is achieved by a combination of waveform processing, Global Positioning System (GPS) time synchronization, high-speed signal processing, and wide-band peak-gated magnetic direction-finding techniques. Processed lightning strike data is sent to subscribers' computer displays via satellite normally within 15-20 seconds of the actual lightning strike. Besides location, the time, polarity, and amplitude of each strike is transmitted to the recipient.

LIGHTNING STRIKES CAN BE BEAUTIFUL, but they can also be expensive, dangerous, and even deadly.

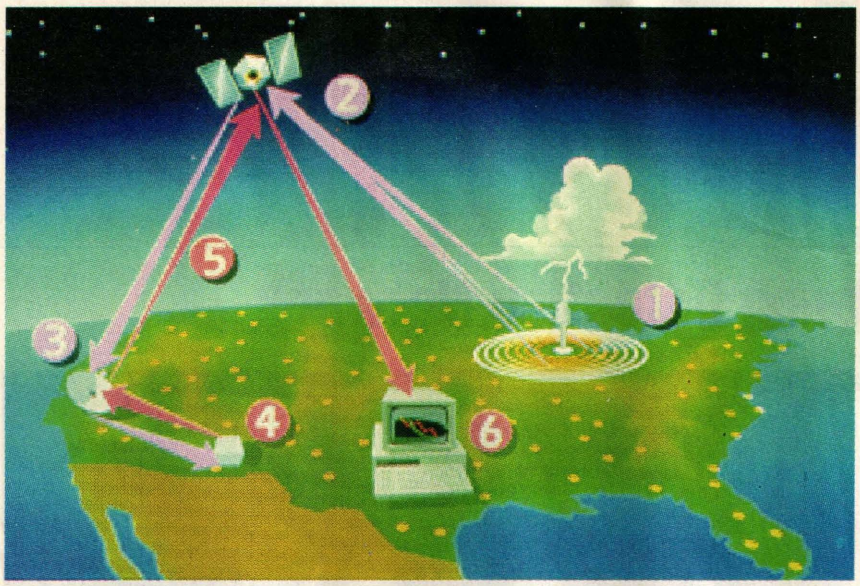
A Growing System

The NLDN provides real time information about lightning strikes as well as a historical archive data library containing over 160 million flashes from 1989 to the present. The NLDN is the result of over twenty years of research and development first initiated by the Electric Power Research Institute (EPRI), the research arm of the electric power industry. The original objective was a system to help utilities make decisions about line-maintenance priorities, effective crew dispatch, and future design and placement of utility lines to reduce lightning damage and to make faster repairs should lightning strike. The NLDN was originally developed by the State University of New York at Albany in cooperation with the Bureau of Land Management and the National Severe Storms laboratory. The final implementation of the technology was developed by GAI.

The system is undergoing a dramatic expansion, and will soon be known as the North American Lightning Detection Network (NALDN). That's because Environment Canada's Atmospheric Environment Service has contracted with GAI for a companion Canadian Lightning Detection Network (CLDN) that will be integrated with the NLDN. When completed, the NALDN will cover the North American land mass south of 60 degrees North Latitude to the northern border of Mexico, and extend from the Pacific to the Atlantic Oceans. The combined system will include 105 ground-based sensors in the U.S. and 81 other sensors in Canada.

Users and Applications

Users of the NLDN's real-time and historical lightning data include the National Weather Service, NASA, the FAA, and the military. The data is of



HOW THE NLDN WORKS: 1. Sensors transmit data to satellite; 2. Satellite relays information to earth station; 3. Data is transmitted to NCC via land-lines; 4. NCC processes data; 5. Processed data is relayed back to satellite; and 6. Lightning data is displayed within seconds of an occurrence.

value for power-quality assurance, aviation, forensic analysis, personnel and equipment protection, mining, insurance-claim investigation, meteorology, and many other applications. For example, historical data is provided to the insurance industry for lightning damage and claims verification. Being able to verify the existence or absence of time-coincident lightning in the vicinity of a policyholder's claim for lightning-caused property damage reduces the cost of investigating claims. Likewise, utilities can use NLDN data in resolving warranty claims. When suppliers deny a claim because they say the damage was caused by an "act of God", archival data can show there was no lightning activity when the piece of equipment went down.

GAI provides a wide variety of NLDN products, and each can be tailored to meet the needs of individual subscribers. For instance, THUNDER is a software package that operates with a real-time link to the NLDN via either a satellite downlink or modem connection. THUNDER's dual-monitor, display package provides uninterrupted viewing and tracking of lightning events in a particular region as they occur.

The Fault Analysis and Lightning Location System (FALLS) was specifically designed to address the Electric Power industry's lightning concerns. FALLS, with its various modules and reports, allows complete, in-depth analysis of lightning and its cause and effect on, and association with, power delivery-system reliability. FALLS can be used to assess lightning-exposure risk for power lines, telecommunication lines, railways, gas pipelines, forested areas, or even single customer facilities.

FAULTFINDER is another product that can determine whether lightning strikes played a role in an outrage or momentary interruption. It can eliminate the problem of erroneously categorizing unverified outages as lightning-related, ignoring the possibility of equipment malfunction, improper grounding, wind and other factors that affect system reliability.—BILL SIURU PT

FOR MORE INFORMATION

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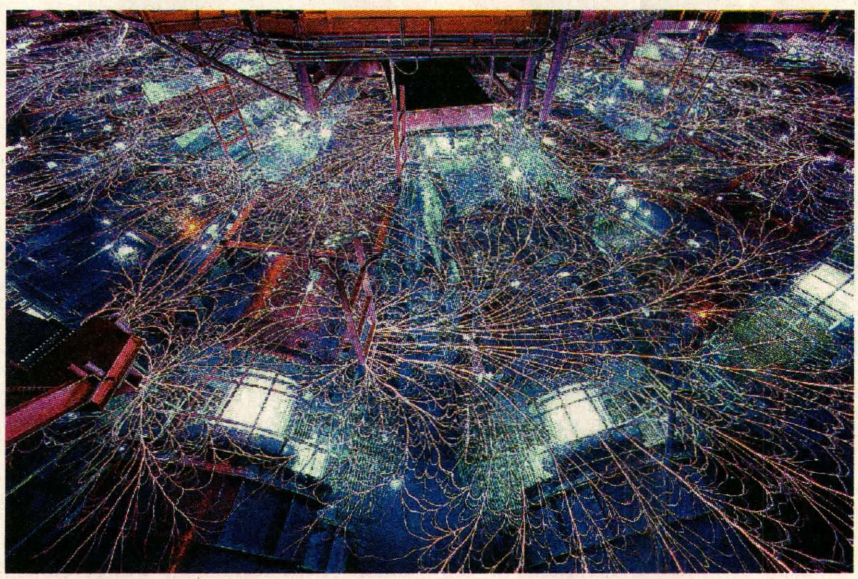
Accelerator Takes A Giant Step Towards Fusion

Sandia's Z accelerator—the most powerful producer of x-rays in the world—has recently produced another world record for power output, making it a viable contender in the quest to achieve sustainable nuclear fusion. The most recent increase—bringing its output to 290 trillion watts (terrawatts)—shatters by nearly 40 percent its previous world record set last summer.

The Z machine works by firing massive bursts of electricity to superheat a miniature oven, a hohlraum, which is about the size of a sugar cube. The electrical energy fired at the target is the equivalent of 60 times the world's usage of electrical power at a given moment.



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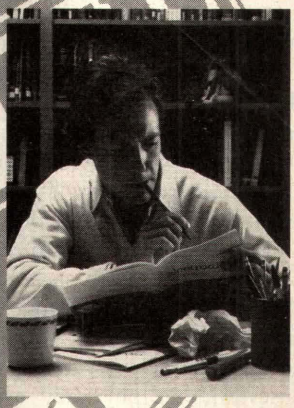

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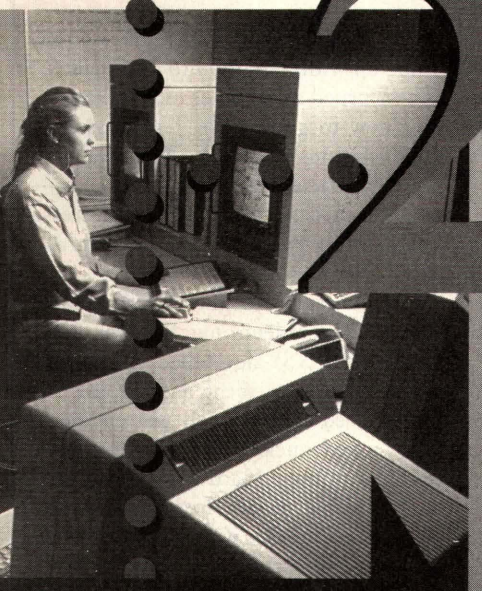

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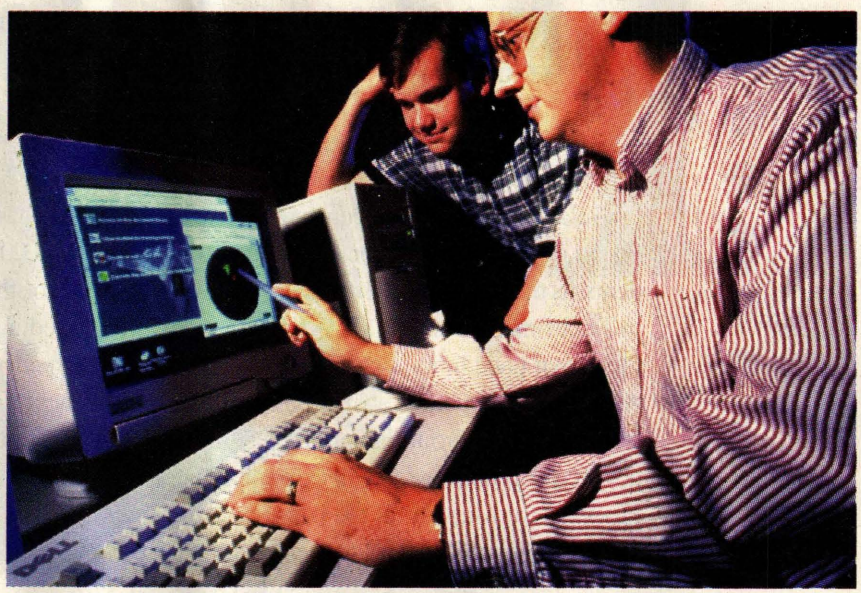
Lasting only a fraction of a second, the shot generates temperatures greater than 1 million degrees, ever closer to the 2 to 3 million degrees required for nuclear fusion. Temperature is particularly important in the quest for fusion, in which much more energy is created than used.

In the past 18 months, the Z machine has increased its output by more than seven times, starting from 40 terrawatts. Before that, it took 25 years for a succession of Sandia accelerators to reach the 40-terrawatt level. Each successive test has helped lay the groundwork for sustainable nuclear fusion. It also has provided data to help test U.S. nuclear defenses without physically exploding large-scale devices. PT



RESEARCHERS BRIAN KEETON AND WILL NELSON at the GTRI at interactive how-to guide called the Test Engineer's Workstation *(TEWS)*.

Ultrasound Improves Truck Tire Safety

At the University of Illinois at Urbana/Champagne (UIUC), a fast, low-cost inspection system has been developed for evaluating the structural integrity of new and used steel-belted radial truck tires. Using ultrasonic sound waves, the instrument detects ply delaminations; weakened, damaged, or broken cords; and other, potentially dangerous, hidden defects. Professor of General Engineering Henrique Reis and graduate student Paul Golko use an analytical, nondestructive evaluation technique called acousto-ultrasonics to check for hidden damage.

The first step is to inject a sound wave into the side of the tire, using an ultrasonic transducer. The ultrasonic pulse then propagates along the sidewall, where it is picked up by another transducer and analyzed by a computer.

"Tires are scanned with measurements recorded every 0.3 degree of tire rotation, for a total of 1200 samples," Reis said. "This angular sampling interval was chosen because it is smaller than the spacing between radial cords on the tire at the transducer locations. Therefore, we can test for damage in each individual cord. The entire measurement takes less than a minute per tire."

By studying the attenuation characteristics of the transmitted signals, the researchers can analyze damage within the tire. "We can detect strained or damaged cords because the sound wave is not transmitted as efficiently as in a normal steel cord," Reis said. "The greater the damage, the higher the signal attenuation. If the signal disappears, the cord is broken. By studying the signals, we can also detect areas where the steel cords and rubber have separated."

A color-coded display is used to graphically represent the results. It shows not only regions of broken or damaged cords, but also areas where the steel cords are weakened to the point where the tire should be removed from service. By evaluating the residual strength in the sidewalls, the instrument can determine a tire's remaining useful life and whether it is worth retreading.

"For safety reasons, we don't want to use bad tires," Reis said. "But for ecological reasons, we don't want to throw away good tires that can be retreaded. This instrument enables us to easily distinguish between the two." PT

Test Engineer's Workstation

Technical manuals can be massive and intimidating, so researchers at Georgia Tech Research Institute (GTRI) came up with a solution to "manualitis." They turned a computer into an interactive how-to guide—the Test Engineer's Workstation (TEWS). The machine uses hypertext links and multimedia—graphics, video, and sound—to decrease the learning curve on complex test and evaluation jobs.

At the request of the U.S. Air Force, the GTRI's Electronic Systems Laboratory (ELYS) developed TEWS. It was designed to meet an ongoing Air Force need to bring new test engineers up to speed quickly in electronic-warfare systems testing. Hard-copy documents and word of mouth from people who had done it before were the only previously available resources. With TEWS, engineers can quickly find out what a piece of equipment does and what it did last time.

The GTRI developers distilled massive test manuals into on-screen programs that lead test engineers through evaluations of new and upgraded systems, helping them plan, conduct, and accurately analyze a test. In developing the TEWS platform, the team combined video and audio materials—from lectures to slides and video—onto CD-ROM discs that are accessed from Windows PCs. Users can click on any on-screen subject to view and listen to the requested information, and they can replay any segment they choose.

TEWS aids engineers in the analysis of test data through its ability to use the Automated Data Reduction Software (ADRS).The software computes performance and effectiveness measures to satisfy test-program requirements for electronic-warfare systems. Implemented as a Microsoft Windows application, ADRS helps ensure the quality of data collected and that the resulting analysis satisfies the test objectives. As important, TEWS helps developers design their own test plans from scratch. The program even has pop-up help boxes with questions that designers need to ask themselves.

Users can customize TEWS to fit their location and test-facility type. Since a video-capture card lets users add standard video input to existing test programs, this feature allows online information about defense systems to be added as they are tested.

"Maintaining good descriptions of results means that if, say, two years later you make another change and you have to retest, you don't have to start over," says Brian A. Keeton, an ELYS research engineer, who works in test process development. "You can compare it to the last test pretty easily."

Several TEWS systems have been installed at the Air Force Development Test Center at Elgin Air Force Base, the Air Force Flight Test Center at Edwards AFB, and at GTRI to support the defense-systems testing arena. The TEWS approach may have applications in other fields, where on-the-job training, system testing, and archiving of results need to be efficiently combined. PT

You're Never Too Old

For his upcoming 80th birthday on Sept. 22nd, NASA aeronautical engineer Seth Anderson plans to go gliding off Glacier Point again. This will be a replay of his 79th birthday celebration, when Anderson last glided from Glacier Point, more than 3200 feet above the valley floor at Yosemite National Park, CA. He soared on a breath-taking 16-minute hang-glider ride that he videotaped, as he always does.

His hang glider is a NASA spin-off from space research. "It was originally called a Rogallo Wing, for Francis Rogallo, who in the early 60s experimented at NASA's Langley Research Center, Hampton, VA, with a paraglider as a possible landing method for space capsules," said Anderson. "If it had been used for the two-person Gemini capsule, astronauts could have landed on terra firma instead of parachuting to water landings."

SETH ANDERSON hang gliding over Yosemite.

As a contemporary of Rogallo, Anderson knows his NASA history. He began his career at Ames Aeronautical Laboratory, Moffett Field, CA, in 1942. Today, Ames is a NASA research center, where Anderson studies human factors for the agency's Remotely Piloted Aircraft Program. Human factors engineers examine the interactions between human beings and aircraft.

To allow Yosemite visitors to see the park from a bird's-eye view, Anderson has decided to donate his hang-gliding video to Yosemite for playback in the visitor's center. Visitors will be able to see many scenic views of the valley from a unique vantage point.

Hang gliding, Anderson believes, is a spectacular recreational sport. "I started 17 years ago. But hang gliding is an unusual hobby, not for the timid." Anderson has also built an experimental BD-5 turboprop aircraft at his home that he now flies.

Of his planned birthday flight, he says "It'll really be exciting." PT

Aviation Accident Prevention Program

In cooperation with the FAA, NASA is developing an automated system called the Aviation Performance Measuring System at NASA's Ames Research Center (Moffett Field, CA) that could better prevent commercial aviation accidents. By reducing the human labor needed to process the large quantities of performance data received, this program enhances the data collection and cost effectiveness of safety procedures of U.S. carriers.

Aircraft systems that generate performance data are used to troubleshoot potential future aircraft problems. Monitoring over 1200 operational functions of the aircraft, the system provides valuable early warnings of potential problems in numerous areas, including performance, cockpit instrument inputs, electrical equipment, fuel, and hydraulics.

"This gives the airlines an eye on operations that they don't now have," said Linda Connell, director of FAA-NASA's Aviation Safety Reporting System, which complements the $3 million joint research program, funded by the FAA.

Alaska Airlines was the first carrier

to enter an agreement with NASA for collaboration on a suite of system's tools. United Airlines later signed a similar agreement. The system is undergoing operational testing by airline personnel, analyzing data from the first aircraft equipped with Quick Access Recorders.

Under NASA's new Aviation Safety Program, the system will eventually be extended to service the engineering, maintenance, and training needs of commercial airlines; as well as to commuter, cargo, and corporate air carriers. The system provides a prototype of a flight data analysis ground station with broad-based reporting capabilities customized to the needs and operations of U.S. airlines. It includes specific provisions for transfer of prototype products to commercial vendors using present safety programs and technology.

"By incorporating advanced automation techniques, we can detect accident precursors we didn't know existed," said Dr. Richard Keller, research leader for intelligent systems technology. "The carriers also can use the system proactively to forestall future problems by improving training, operations, and maintenance procedures," he added.

Tailless Fighter Flies High

The NASA/Boeing X-36 Tailless Fighter Agility Research Aircraft successfully completed its flight research program—demonstrating the feasibility of future tailless fighters achieving agility levels superior to today's best military fighter aircraft. The project goals are to develop technologies to improve the maneuverability of future fighter aircraft. "All of our project goals were met or exceeded," stated Mark Sumich, X-36 project manager at NASA's Ames Research Center, Moffett Field, CA.

During the final flight phase, the X-36 project team examined the aircraft's agility at low speed/high angles of attack and at high speed/low angles of attack. "We also achieved the final flight's goals to expand the X-36's speed envelope up to 206 knots (234 mph)," Sumich said.

Thirty-one flights were made during the six months of the flight research program at NASA's Dryden Flight Research Center, Edwards, CA. The X-36 flew a total of 15 hours and 38 minutes and used four different versions of flight control software. The aircraft reached an altitude of 20,200 feet and a maximum angle of attack of 40 degrees.

The 28-percent scale X-36, built by the Boeing Phantom Works in St. Louis, MO, is designed to fly without the traditional tail surfaces common on most aircraft. The X-36 is 18 feet long with a 10-foot wingspan; is three feet high; and weighs 1270 pounds. The aircraft is powered by a Williams Research F112 turbofan engine that provides 700 pounds of thrust. It is remotely controlled by a pilot in a ground station cockpit, complete with a heads-up display. The pilot-in-the-loop approach eliminates the need for expensive and complex autonomous flight-control systems.

The X-36 Flight Test program team was comprised of employees from Boeing, Ames, and Dryden. Beginning in 1989, Ames and the Boeing Phantom Works developed the technologies required for a tailless fighter—a project that was jointly funded under a roughly 50/50 cost-sharing arrangement. To develop, fabricate, and flight test the two prototype aircraft cost approximately $20 million.

With the flight-test program completed, the X-36 will be placed in flyable storage condition in a hangar at Dryden. "Discussions are underway about what to do next with both of the X-36 aircraft," said Gary Cosentino, X-36 deputy project manager at Ames. "There is a potential for other technologies, such as a highly advanced reconfigurable flight control system, to be incorporated on the aircraft and possibly flight tested in the future." PT

Intelligent Machines Inch Forward

Representatives of Sandia and the Department of Energy (DOE) met recently to begin developing a road map for the future of the United States' robotics and intelligent machine industries. Also attending were representatives of other agencies, including the Department of Defense, the Department of Commerce, NASA, and the National Science Foundation.

The meeting was a result of Sandia's long-standing efforts to establish a national robotics and intelligent machines initiative based on America's technical excellence in sensors, software, controls, and computers—elements that turn simple robots into intelligent machines. An earlier milestone in this effort was the National Needs Workshop on Robotics in Albuquerque, NM. Robotics experts from around the country attended this workshop, which led to a day-long Congressional Expo on Intelligent Machines that was held on Capitol Hill.

Speakers at the Expo stressed that the United States has the opportunity to become a global leader in the robotics and intelligent machines industry. But government, academia, and industry must act quickly to achieve a leadership position, they said.

Sen. Jeff Bingamin, of New Mexico outlined his national action plan during a keynote address at the Expo, recommending that DOE and NASA establish three test-bed centers for robotics and intelligent machines at Sandia, Carnegie Mellon University, and the Jet Propulsion Laboratory that would be open to other federal agencies and private-sector researchers. The centers would provide prototyping capability for potential users, serve as meeting grounds for researchers from different disciplines, develop and disseminate generic software for robots, and establish training courses for young professionals.

During the Expo, Sen. Pete Domenici, New Mexico's senior senator, also stated his support of the plan. In his speech, Domenici said the robotics industry is poised to quickly rival the enormous and ever-expanding telecommunications industry. He added that Sandia is a logical location for a national test bed where government, industry, and academia can work together on research and development to commercialize new robotics and intelligent machine-products.

The Expo prompted a bipartisan Senate-House task force to endorse Bingamin's plan to establish the national initiative for intelligent machines and to request the recent meeting of high-level representatives. PT

COMPUTER CONNECTIONS

continued from page 16

have been none too shabby either. I'm referring to Delphi 3.0, JBuilder 2.0, and C++ Builder 3.0 (CB3 for short).

I still do more development in Delphi than any other environment, and it kicks. However, CB3 is highly attractive and may finally force me to switch. It takes the best Delphi has to offer (the development environment and the VCL), throws in several major enhancements, and numerous C/C++ specific features.

As with Delphi, but even more so, you can use CB3 for both application and systems development. At the application level you have your choice of three major Windows-class libraries: MFC, OWL, and VCL. MFC, of course, is the Microsoft Foundation Classes; CB3 supports version 4.2. OWL is Borland's Object Windows Library, at one time a competitor to MFC, but no longer. I guess there are still some people using it in a legacy mode. VCL is the Visual Component Library from Delphi.

On-screen, CB3 looks almost exactly like Delphi. In fact, the visual-development components (buttons, forms, etc.) are the Delphi components. You can install Delphi-developed components directly into CB3; unfortunately, the converse is not possible. Nonetheless there is still a high degree of compatibility and interoperability between the two.

Borland has discontinued Borland C++; CB3 is the company's C/C++ compiler from this point forward. There is no 16-bit support. CB3 has an excellent new project manager, DLL and EXE debugging, and fully supports the recent ANSI C++ standard, including the Standard Template Library (STL), and more.

Bottom line: If you're a C++ developer on Wintel, you owe it to yourself to take a close, hard look at CB3.

Java Notes

You may have heard about HP's introduction of a Java dialect. The anti-Java crowd instantly took this as a sign of technology fragmentation, a loss for Sun, and a win for Microsoft. I'm not so sure. HP's announcement, one might suspect, concerns a version of the language targeted for embedded use-in laser and ink-jet printers. Clearly, there is some bad blood between Sun and HP over this, but it seems to be more a sign of Sun's stretching itself too thin than anything.

Clearly, though, fragmentation is occurring. *PC Magazine's* special issue on Java (5/7/98) reported (for the second year in a row) that Microsoft's Java Virtual Machine (JVM) is faster and more compatible with the specs than all others, including Sun's. Meanwhile, Microsoft has been forced to stop using the Java logo because of its proprietary extensions to the language. Odd, no?

Sun wants to control the standard, but nasty HP and nasty Microsoft won't let it. Why is that? Why does no one complain about Microsoft holding the Basic standard, or for that matter HP the PCL (Printer Control Language) standard? Those are all *de facto* standards, not governed by any standards body, but owned and strictly controlled by single companies.

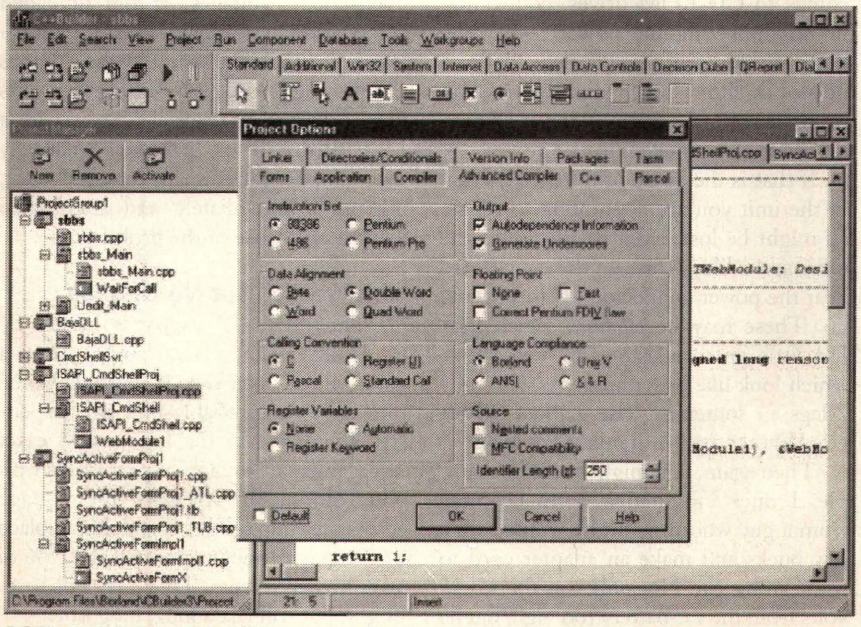
There are several million programmers using proprietary, single-sourced Visual Basic to produce real software that real people use in real companies every day. By contrast, Java is off by an order of magnitude or two in the number of developers, and by many orders of magnitudes in the number of actually running applications. So why the big fight over Java, and no fight over VB?

Let's all demand that HP go public with PCL! (That's a joke. I'd rather see Adobe go public with PostScript).

Meanwhile, Borland's JBuilder keeps racking up kudos; it's consistently rated one of the top two Java development environments.

Are you interested in Java—for embedded use or otherwise? Let me know; I'm considering adding some ongoing coverage.

See you next time. Until then, you can drop me a line via e-mail at jeff@ingeninc.com. EN



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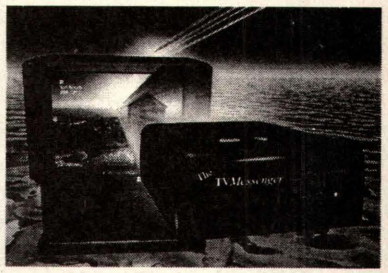

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BY SAM GOLDWASSER
SERVICE EDITOR

Common CD-Player/CD-ROM Problems and Cures

LAST TIME, WE DID SOME GENERAL MAINTENANCE TASKS SUCH AS CLEANING AND LUBRICATION. IN MANY CASES, THAT MIGHT BE ENOUGH TO RESTORE YOUR PLAYER OR DRIVE TO NORMAL OPERATION. THIS MONTH, WE'LL TURN OUR ATTENTION to what to do when such general maintenance is not enough.

CD Player is Dead as a Brick

If the heading above more-or-less summarizes the state of your unit, the first step is to check the obvious. Make sure the input power cord is plugged in and good, inspect the fuse (if present), and verify that the power switch (if present) is functioning normally. Also make sure that the outlet to which your unit is connected is indeed supplying power and/or that the batteries are good.

After that, you must turn your attention to the power-supply components. Locate the outputs of the power transformer and trace them to the rectifiers and associated filter capacitors and regulators. While the actual voltages will probably not be marked, most of the power in a CD player will be within ±15 VDC. The voltage ratings of the filter capacitors and regulators, if you can read them, will provide clues as to the correct power-supply voltages.

Most component CD players use linear power supplies so troubleshooting is straightforward even without a schematic. For reference, the power-supply schematic for a Technics SLP-310 is shown in Fig. 1. That unit is typical of those that use either discrete pass transistors (as in this case) or common IC regulators like the 7805, 7815, 7915, and similar devices.

Portable CD players and CD-ROM drives often use DC-DC converters to produce the various voltages required, and those are much more difficult to troubleshoot, even with a complete service manual. Doing anything other than checking for shorted or open components is virtually impossible without an accurate schematic.

Power-Adapter Blues

When it comes to portables, one of the common causes of damage is the use of an incorrect power adapter. When it comes to CD-ROM drives, connecting or disconnecting the power lead while power is being supplied is also a definite no-no. In either case, major damage can result despite the various types of protective measures taken in the design.

If that is the cause of the malfunction in the unit you are attempting to repair, all might be lost, Even so, check for the obvious—a blown fuse on the main board near the power connector—before giving up. These may be *picofuses.* which look like little green resistors; IC Protectors, which look like tiny transistors with only 2 legs; or something else marked F, ICP, etc. Who knows? You might get lucky.

Then again, you might not. For example, I once inherited a Sony Discman from a guy who thought he would save a few bucks and make an adapter cord to use it in his car. Not only was the 12–15 volts from the car battery too high, but he got the polarity backwards! He blew the DC-DC converter transistor in two, despite the built-in reverse-voltage protection, and he fried the microcontroller. Needless to say, the player was a total loss, except for some of the mechanical parts, which I salvaged for future use.

The moral of this story is that the voltage, current, and polarity ratings marked on portable equipment are there for a reason. Voltage ratings should not be exceeded. Using a slightly lower-voltage converter will probably cause no harm, though performance could suffer. The current rating of the adapter should be at least equal to the printed rating of the equipment you intend to power. Polarity, of course, must be correct. If you are not 100% certain of your adapter's output polarity, double check it with a voltmeter before plugging it in.

Keep in mind that some identically marked adapters deliver widely different open-circuit voltages. If the unloaded voltage reading is more than 25% to 30% higher than the marked value, be cautious about using the adapter. If the player acts in any strange or unexpected way with a new adapter, if any part gets unusually warm, or if there is any unusual odor, unplug it immediately and attempt to identify the cause of the problem.

Unit Works, But No Display

Sometimes the display is backlit by miniature incandescent lamps. After a while, these burn out. If you take some time, you can probably find an inexpensive alternative to the high-priced exact replacements. Test any suspect lamps with your ohmmeter. Measure the voltage across the lamp terminals and then replace the lamp with one that is rated at a 25% to 50% higher voltage. They may not be as bright, but will last a long, long time.

If the lamps are not at fault, or if

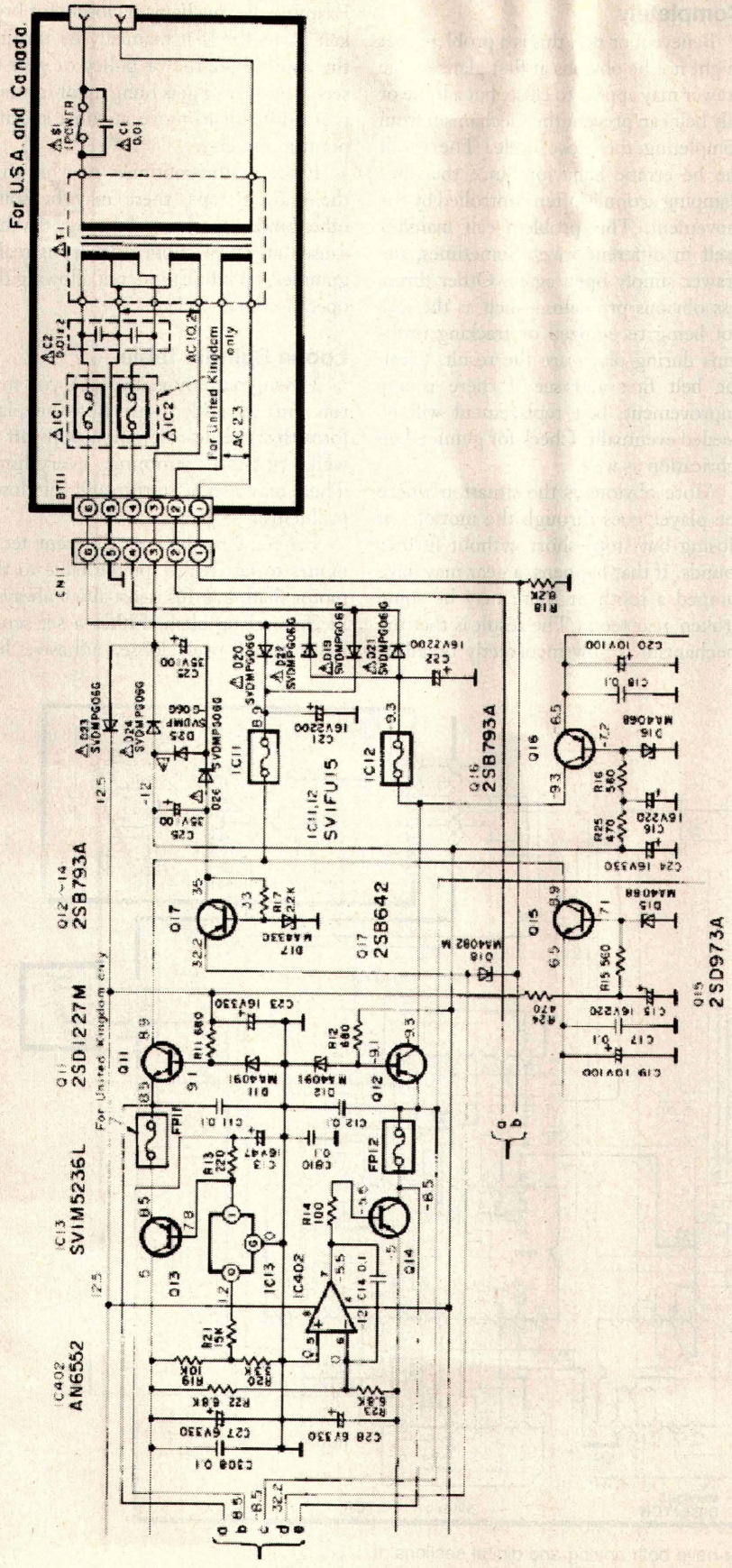

FIG. 1—MOST CD PLAYERS, like this Technics SLP-310, use a linear power supply, so troubleshooting is usually fairly straightforward.

there are no lamps, check for power to the display. At the same time look for bad connections or connectors that need to be re-seated. There might also be a power-supply or driver problem such as a missing voltage for a vacuum fluorescent display.

CD Player Ignores You

Symptoms here are that the display comes up normal when power is turned on, but all, or some commands are ignored. There are several possible causes:

- Front-panel problem: If one or more buttons are not responding, try to re-seat the internal cables. Clean or replace the offending switch or switches. If the player has a remote control, see if it is operating correctly.
- Reset failure: If the player has failed to reset properly and is not ready for user input, check the power-supply voltages and re-seat internal connectors.
- Controller and/or driver electronics: These could be defective for the affected functions. Once again, check the power-supply voltages and re-seat the internal connectors.

Drawer Does Not Open or Close

If the drawer does not open when the front-panel button is pressed, listen for a motor attempting to open it. If you hear the motor whirring but nothing happens, check for an oily or loose belt, or another mechanical fault. You can clean the belt as a temporary repair, but replacement will be needed eventually. If there is no motor sound (listen carefully), the motor, control chip, or front-panel pushbutton could be bad. If the unit has a remote, see if it will open the door. If it does, check the pushbutton for that function on the unit first.

Erratic Drawer Operation

You are about to remove your favorite CD from the unit but the player beats you to it—it closes the drawer and starts to play the disc over again. Other symptoms are that the drawer reverses course halfway out, or the drawer motor continues to whir even after the door is fully open or closed, and the front panel is then unresponsive.

These kinds of problems are usually caused by dirty contacts on the door-position sense switches. There are usually three sets of switch contacts associated with the drawer mechanism. If any of those get dirty, worn, or bent out of place, erratic door operation results.

Those sense switches are:

- Drawer-closed sense switch. Dirty contacts may result in the drawer motor continuing to whir after the door closes and the front panel may then be unresponsive. Eventually, the door may open on its own.
- Drawer-open sense switch: Dirty contacts may result in the drawer motor continuing to run after the door opens and the front panel may then be unresponsive. Eventually, the door may close on its own.
- Drawer-pushed sense switch. Most CD players allow the user to start play by gently pushing on the drawer. That depresses a set of switch contacts. If these contacts are dirty, the drawer can decide to close on its own or to reverse direction in the middle of opening or closing.

The solution to all three of these problems is to locate the offending switches and clean their contacts. Those contacts are rarely protected from dust, dirt and grime. As a result, the problems outlined in this section are quite common.

Drawer Does Not Close Completely

Believe it or not, this is a problem that might not be obvious at first glance. The drawer may appear to close, but a loose or oily belt can prevent the mechanism from completing the close cycle. The result can be erratic behavior, since the disc-clamping action is often controlled by the movement. This problem can manifest itself in different ways. Sometimes, the drawer simply open again. Other times, less obvious problems—such as the disc not being recognized or tracking problems during play—are the result. Clean the belt first and see if there is any improvement; belt replacement will be needed eventually. Check for gummed up lubrication as well.

More obvious is the situation where the player goes through the motions of closing but stops short without further sounds. If that happens, a gear may have jumped a tooth or there may be some broken gear teeth. The result is that the mechanism is now incorrectly timed or not able to complete the operation. Examine the mechanism closely for broken parts. Cycle it manually by turning the appropriate motor pulley or gear to see if the drawer gets hung up or is much more difficult to move at some specific point in the cycle.

If the motor continues to whir after the drawer stops, there may be some other kind of mechanical damage that has caused an obstruction, or there is really gummed-up lubrication, not allowing the operation to complete.

Loose Spindle Table

When you remove the CD, you may run into an added surprise—the platform that the disc sits upon pops off as well, possibly jamming everything. There may also be startup and spindown problems.

Different models use different techniques to fasten the spindle table to the motor shaft, but this is just about always a mechanical problem. Either a set screw has worked itself loose, adhesive has

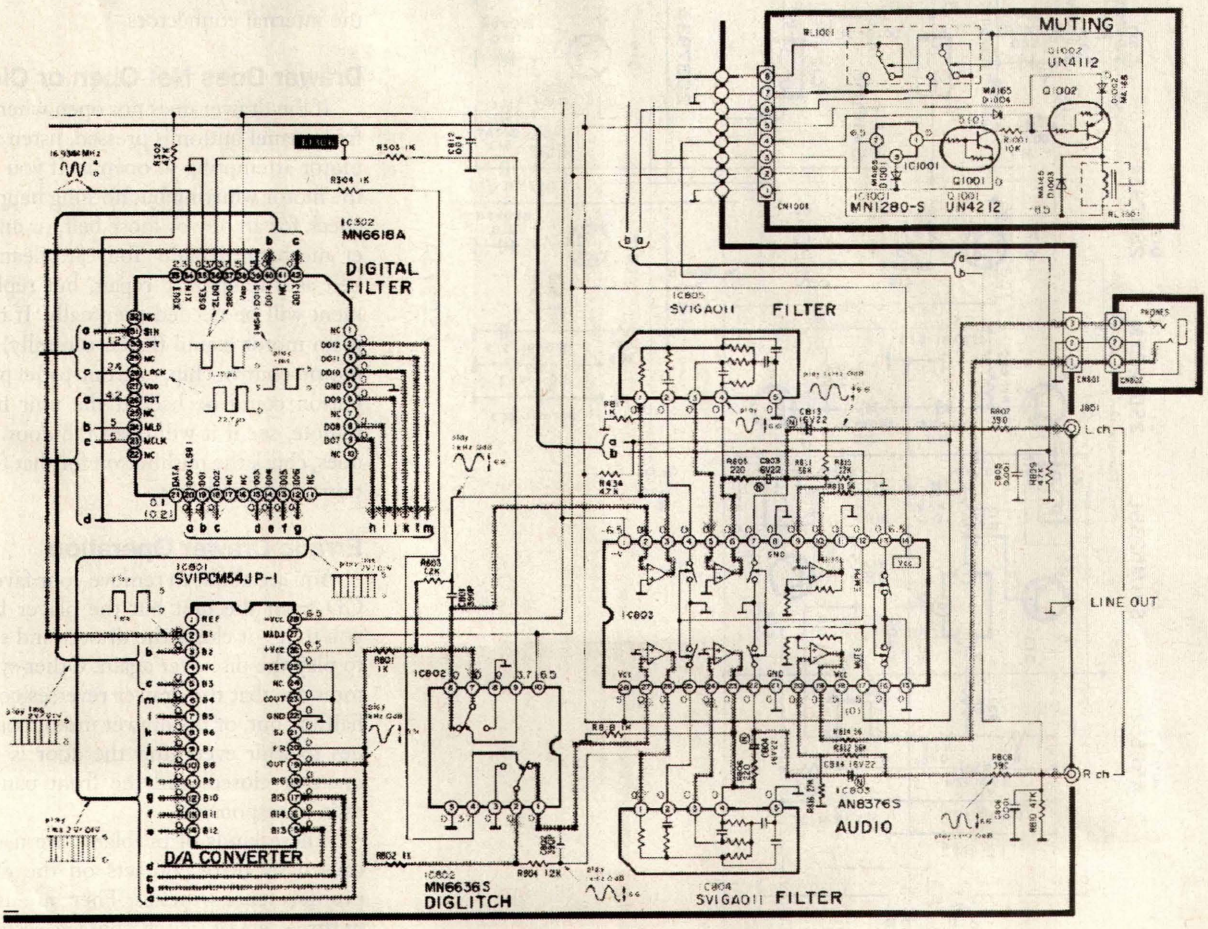

FIG. 2—THE AUDIO CIRCUITS in a CD Player have both analog and digital sections. If the problem is in one of the digital LSI chips, there is little you can do. Dealing with the analog circuits is a bit easier.

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weakened, or a press fit has come undone.

If there is a loose or missing set screw, get a new one or tighten the old one. If there is no set screw, a drop of epoxy cement may save the day. However, height is important to guarantee proper focus range, so be careful if there is no definite stop. The disc and rotating clamper magnet must both be clear of any fixed structures and be the correct distance from the optical pickup. Where something irreversible is involved, like using epoxy adhesive, checking the service manual becomes a must—the specification is usually 0.1 mm accuracy.

A loose spindle table can also cause continued spinning upon eject, or sluggish or noisy startup or seek; since if the spindle is loose, the motor cannot properly control disc speed during speed changes.

Intermittent Operation

When a CD player appears to have a "mood" problem—playing fine sometimes or for only part of a disc, or aborting at random times—there are several possible causes. Those include a defective disc, a dirty lens, various mechanical problems, dirty or worn interlock or limit switch, bad connection to the interlock switch (mainly in portables and boomboxes), flex cable with hairline cracks in one or more conductors, other bad connections, missing optical deck ground/shield, or power-supply problems. Let's go through some of those:

• Dirty, Scratched, or Defective CD: It might be easy to overlook the obvious, so the first thing you should do is to confirm that the CD is not the problem. Clean the disc and/or try another one.

• Dirty Lens: A player that accepts some discs and not others, or accepts discs sporadically, may simply need its lens glass cleaned.

• Mechanical Problems: This usually involves oily and/or flabby belts preventing full drawer closing, or gummed-up lubrication on the sled (may fail depending upon ambient temperature). For example, if the music gets stuck at about the same time on every disc, then there may be gunk on the end of the sled track, preventing the sled from moving any further. That is especially likely to manifest itself if you just purchased a disc with an unusually long playing time. NOTE: Some players simply will not play discs that exceed about 74 minutes of playing time, the maximum CD playing time if the CD specification is followed. However, some discs may be as long as 78 minutes or more, which means that some aspects of the CD specifications were compromised.

• Dirty Switches: Oily film or oxidation may be preventing any one of the limit or interlock switches from making a reliable contact. If this is the problem, the player may stop at random times, fail to accept a disc, close the drawer without your permission, etc. Use contact cleaner and typing paper to clean the contacts. Disassembly may be required to get at the contacts of enclosed switches.

• Cracks in Ribbon Cable: The moving and fixed parts of the optical pickup are often joined with a printed flexible cable. Constant flexing may cause one or more of the copper traces to crack. This may show up as an inability to get past a certain point on every disc (the player might shut down or start skipping at about 23 minutes into every CD).

• Bad Connections: There are often many little connectors used to send signals and power between the optical deck and the main circuit board. These are usually cheaply made and prone to failure. Wiggling and re-seating those may cure your problems. There may even be bad solder connections on the pins of the connectors or board-mounted switches. Slight flexing or just expansion and contraction may result in intermittent shutdown or other problems. Note that this type of failure is most common in portables and boomboxes because they are more likely to take physical abuse.

• Missing Shield: A missing shield between the analog ground and the optical deck can result in all kinds of erratic behavior. If your intermittent problems started after you had the player apart for some reason, check that you replaced the grounding strap or metal strip and/or didn't accidentally disconnect or break any shield connection on the ribbon cable to the optical deck.

• Power-Supply Problems: Problems in the power supply could cause the types of intermittent problems listed above, but it is unlikely. That said, if you have an oscilloscope, it certainly does no harm to check the power-supply outputs for ripple—a filter capacitor may have dried up and lost most of its capacitance.

Heat Problems

A CD player that becomes noisy, or a CD-ROM drive that fails to recognize discs or fails to reliably read data after a few minutes of operation, may have a component that is heating up and changing value. There is not very much in a CD drive that runs hot; however, specific components do sometimes fail in this way. The way to diagnose and locate problems of this type is to the use some of the same techniques that you would apply to finding overheating components in a TV or in a computer monitor.

Your main tool will be a can of cold spray ("circuit chiller" or, in a pinch, a hair dryer set to 'no heat'), coupled with an oscilloscope (if one is available). What you are going to do is to try cooling various components to try to identify the one that is bad and causing the problem. However, if you are trying to deal with a unit that dies completely and suddenly after it heats up, this may not work very well since you may not have enough time to detect changes in behavior. If you are dealing with CD player that will play, but has tracking problems and/or audio noise, you should be able to monitor the playback quality by simply listening for improvement when you have cooled the flaky part. For a CD-ROM drive, play an audio disc if possible, since it will provide the feedback you need to locate the bad part without (hopefully) the drive shutting down due to data errors or inability to reliably access the file system.

Here's a good procedure to follow when making this test: First, run the unit with the covers removed and see if that has an effect that confirms a thermal problem. Next, use the cold spray on individual components. Start with a quick burst on an LSI chip and wait a few seconds for something to change. If nothing happens, move on to the next component. If you are using the hair dryer (no heat!), make a funnel out of paper to direct the air flow. Since this is not really cold air, expect to wait a bit longer to see any effect.

If you have a scope available, it would be wise to look at the RF "eye" pattern while cooling components and see if it changes in amplitude and/or quality over the course of an hour. If it does change, you may have an overheating problem in the laser diode or its power supply. (The "eye" pattern will be discussed in a future column, so you may want to hold off until then for this "advanced" troubleshooting!)

Audio Problems

Silly me, what other kinds of problems are we talking about? What I should

have said: audio signal-chain problems. The player appears to be working fine (the disc is spinning; the time is incrementing correctly; seek, search, and play operations behave normally) but there is either silence, noise, or distortion on one or both channels.

Note: These sorts of audio symptoms could also be caused by problems with servo alignment, the optical pickup, or front-end electronics. Troubleshooting those types of problems will be covered in future columns. Therefore, if your problems are as outlined in the paragraph above, you might want to hold off on attempting to troubleshoot your unit until those topics are covered. Remember, patience is a virtue, and in this case can save you from wasting time troubleshooting a problem in one part of the player when its cause actually lies in another.

Getting back to the audio signal chain, there is a distinct boundary between the digital section where audio information is encoded digitally and the analog domain where it is an electrical waveform. The diagram of the audio circuitry of the Technics SLP-310 in Fig. 2 shows a typical organization. Note the separate circuitry for the D/A converter, digital filter, audio mute, and post analog filtering.

Problems in the digital domain will usually be obvious to the point of being gross—extreme noise, noise correlated with the signal level, extreme distortion, tones or frequencies that with no stretch of the imagination were present in the original music, etc.—and will be distinctly different than the kind of noise or audio distortion we are accustomed to in stereo equipment. Even small errors in the digital reconstruction can result in extreme changes in the audio output. For example, a single bit error if in the MSB can totally corrupt the resulting waveform. Simple errors can result in sound frequencies not present in the original. Fortunately, these sorts of errors are relatively rare as most of the circuitry is inside of very reliable LSI chipsets.

However, if the CD is recognized and appears to behave normally except that there is absolutely no audio output, there can be problems in the audio-decoding LSI chips. Other than hoping for an obvious bad connection, this is way beyond the scope of anything you can hope to repair without the service manual, test equipment, and a miracle.

Problems in the analog sections—D/A(s), sample-and-hold(s), post analog filters, and muting relays—produce effects that are more familiar: noise, a decrease in signal strength, and distortion. Except for parts of the D/A, which may be shared, there will be identical left and right channels to compare if an audio problem develops.

Note that if only one channel is affected, then the problem most likely has nothing to do with tracking, the laser, or the mechanism. Coming off of the disc, the left and right channels are interleaved on a sample (16 bit word) basis so any disc or pickup problem would equally impact both L and R.

That means that you are left with the D/A(s), sample-and-hold(s), the filters, and the muting circuitry as your most likely culprits. Many CD players multiplex the D/A between L and R, so in these, even the D/A is ruled out since most of its circuitry is common.

Now, how do you go about tracking down the source of your problem? Swapping components one at a time between the identical left and right channels is a valid diagnostic technique. Here are some other notes and suggestions:

Players without digital filters (or oversampling) have fairly complex analog filters after the D/A. A bad or noisy component could conceivably be your problem. Even players with fancy oversampling have some kind of a final analog (anti-aliasing) filter. On an older player, there is probably a lot of discrete circuitry in the audio section.

If you can get to the components in the analog filter (some are potted), then, with a test CD that has a "silence track" and a scope or signal tracer, you should be able to find out where the noise is being introduced. If the player has separate D/As, then one of those would also be suspect.

There might be separate power supply outputs for the audio section (this will be more likely with fancy expensive players). In this case, a failure of one of the supply outputs could result in either distorted audio or no sound at all.

The following will mostly result in static type noise, hum, or erratic audio (sound not coming on or partial or total dropout for one or both channels):

Don't overlook the simple problems of dirty contacts on the RCA jacks or bad connections where they are soldered to the main circuit board. Test by jiggling the cable connectors and/or prodding the circuit board near the RCA jacks. The cable may be bad (from flexing) as well—try another one.

Check the connections and controls on your amplifier and other audio components as well! Any bad connection in the audio path can lead to audio signal-chain symptoms. Clean, repair, or replace, as appropriate. Perhaps your poor, helpless CD player isn't even at fault!

Dirty muting-relay contacts could result in intermittent or noisy output. If tapping the relay affects the symptoms, this is likely the problem.

To test, remove the relay and bypass the suspect contacts with jumper wires. CAUTION: Turn your amplifier's volume control down when you start to play a disc—there may be unusual loud noises during startup that are no longer being blocked by the muting circuitry. If CDs now play without any audio problems, a bad relay is confirmed.

If that is the case, it may be possible to snap off the relay cover(s) and renew the relay(s) with contact cleaner and a burnishing tool or a strip of paper. Otherwise, replacement will be required.

Wrap-Up

That's it for now. Next time we will get into what the CD player does when you insert a disc—and what can go wrong. In the meantime, if you have any specific problems or questions, you can reach me by e-mail at sam@stdavids.picker.com. For general information on electronics troubleshooting and repair, visit my site http://www.repairfaq.org/, or go directly to the new, expanded, and glorious FAQs at: http://www.repairfaq.org/REPAIR/F_Repair.html. EN

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WAVETEK'S RMS225A IS A TRUE RMS digital multimeter (DMM) with both analog and digital displays and an ELP backlight. The electro-luminescent panel (ELP) backlight, an industry first for DMMs, uses LCD technology. The bright, evenly disbursed backlight is user-activated through the front panel.

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Additional and useful features of the RMS225A include ProbeHold, autoranging, overload alert, oversized display characters, and menu selection of features like min/max and range lock. ProbeHold allows capture of the last stable reading and updating to the next stable reading to be done automatically. In Auto Min/Max mode, measurements of maximum and minimum values are displayed. A beeper sounds when the latest reading is captured and when updated values are shown.

In AutoRel mode, the difference between two measurements can be determined. Autoranging remains in place to record the widest possible range of inputs. Measurement capabilities of the RMS225A include AC/DC current and voltage, resistance, and continuity and diode tests.

The professional class RMS225A is designed for reliability and continuous trouble-free operation. Its 10,000-count, 4-digit oversized character display allows for high resolution, the most accuracy, and maximum readability. In addition, a 41-segment bargraph display helps adjust peaking and nulling circuits. A simplified menu provides the easiest access to features. Measuring approximately 7- by $3^1/_2$- by 1-inches, this DMM is priced at $189.95 and is available through distributors and catalogs.

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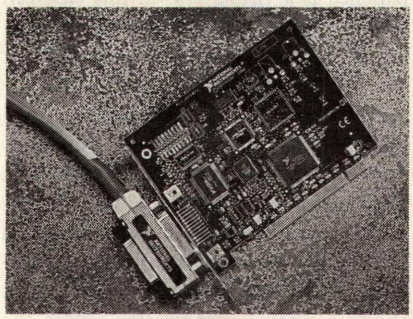
COMBINING THE FUNCTIONALITY of both an IEEE 488.2 Talker/Listener/Controller and a complete GPIB Analyzer, the PCI-GPIB+ offers built-in application debugging, bus diagnostics, and instrument control capabilities for a wide range of test, measurement, and automation applications.

National Instruments' TNT4882 ASIC makes the PCI-GPIB+ a maximum-performance IEEE 488.2 interface, sustaining data transfer rates up to 1.5 Mbytes/s using the IEEE 488.1 three-wire handshake or up to eight Mbytes/s using the popular, high-speed GPIB protocol (HS488). The interface is capable of controlling GPIB instruments as well as troubleshooting a variety of IEEE 488 hardware and software problems. The PCI-GPIB+ can reveal GPIB communication problems, such as addressing inconsistencies, protocol violations, simple bus timeout conditions, and many more.

In addition, the PCI-GPIB+ is completely jumperless and features Plug and Play functionality for easy installation and use. The board comes with standard NI-488.2 driver software. It is also compatible with the company's LabVIEW and



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LabWindows/CVI application software.

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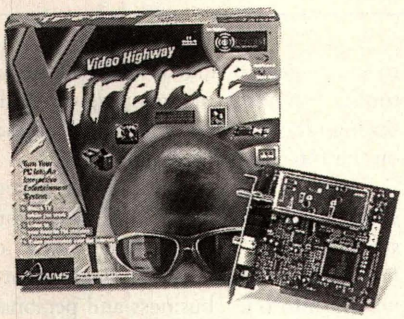
PCI-Video-Capture Card

AIMS LAB RECENTLY ANnounced VideoHighway Xtreme (VHX), a video card that combines every facet of multimedia into an easy-to-use, plug-and-play PCI card. Incorporating Intel Intercast technology, VHX allows users to watch TV, listen to FM radio, use Internet video phones, capture still or full motion pictures, and communicate interactively on their PC. Using VHX, the operator can instantly get more information about a news item, order tickets, purchase products, or participate

in chat sessions—all while watching a TV show.

Besides watching TV, VHX users can connect their VCR, LD, or DVD to watch a movie or connect a Sega, Nintendo, or Sony game console to play a game. VHX also offers video conferencing features and closed captions.



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Included with the card is the Intel Smart Guide, a TV program guide that contains a TV program grid, a browser, and a powerful search engine. The bundled VDOphone software allows the connection of a camcorder or CCD camera for instant video conferencing over the Internet. VHX also captures MS AVI video clips at a speed of 30fps (frames-per-second) that can be used in presentations, Web pages, and video e-mail messages.

You can preset up to 99 FM radio stations. With VHX's 125 channel-ready tuner, viewers can also watch TV in the corner of their PC monitor, with the ability to change the image to full-screen mode. The video-capture card requires a Pentium 90 or better, 16MB of RAM, a PCI expansion slot, Windows95 DirectDraw, and 2MB of VGA memory. It retails for $129.95

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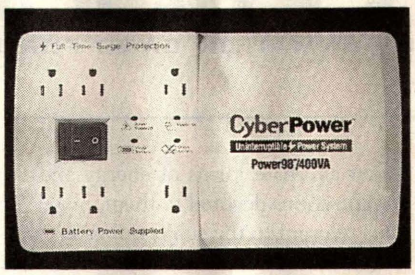
Uninterruptible Power System

CYBER POWER SYSTEMS RECently announced the industry's first full-featured, low-cost surge-suppression and uninterruptible power system, the Power98/250VA. It includes free PowerPanel software, which automatically shuts down the Windows operating system before the computer loses power. This software utility runs under Windows 3.11, Windows 95, and Windows NT. It can be set to automatically save and close any open files within the backup battery time—and to shut down the computer.



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With its advanced microcontroller technology and transformer, the Power98 creates less heat than traditional UPS designs, which results in a compact and lightweight design. Ideal for home, small office, and other cost-sensitive computing environments, the device provides three grounded outlets with full-time surge protection and three grounded outlets with both surge protection and battery backup—capable of supplying power up to 13 minutes. Its battery backup combined with surge suppression protects against all power disturbances: blackouts, brownouts, spikes, sags, and even lightning. The system's high-efficiency batteries are designed to last up to 20 percent longer than ones used in traditional power supply systems.

The device includes top-of-the-line features in a compact, easy-to-use system. The programmable shutdown feature in the PowerPanel software allows the user to set the computer to run a job and leave, knowing the computer will be shut down safely and automatically at a certain hour.

The system's exclusive communications protection ports protect standard modems, PBX systems, or 10-Base-T Ethernet networks. It can be used with any IBM- or Apple-compatible computer, as well as with other electronics. The 250VA comes with a lifetime guarantee up to $30,000 to repair or replace any properly connected equipment ever damaged by a surge, including one caused by a lightning strike. The suggested retail price for the Power98/250VA is $109.

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Maritime SSB Transceiver

DESIGNED AS A SMALL, LOW-power, low-cost HF companion to your current radiotelephone, the SG-2020 is ideal for coastal cruising and long-range cruising sailboats, as well as for powerboats. According to the manufacturer, the unit has the lowest current consumption on the market (less than 300 mA in receive mode).

The transmitter power of the SG-2020 is adjustable from 0 to 20 watts PEP output and covers all HF marine frequencies. The rugged SG-2020, with its extruded aluminum chassis, can be used as a standby, emergency backup transceiver in voluntary fittings. You can communicate worldwide with this unit, and listen to marine frequency traffic, or copy weather-fax transmissions. (The SG-2020 is not FCC-type approved.)

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Among the features of this radiotelephone are user-friendly functions, including SPLIT, RIT, XIT; a fully adjustable IAMBIC "A" mode keyer operating under microprocessor control from 5 to 50 wpm; 40 position simplex or semi-duplex memory storage; a backlit LCD display; and front-panel controls for noise-blanking and for RF gain control. A "D"-cell flashlight battery pack is also available as an option. Its compact size (2.75- × 6- × 7.25-inches) makes installation easy in any vessel.

The retail price of the SG-2020 is $625. A portable version, the SG-PortaPak (complete with battery pack, microphone case, and shoulder strap) is also available at a retail cost of $1195.

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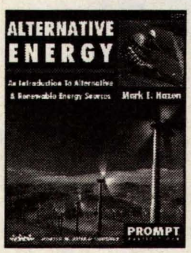

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As populations increase and third-world countries start up more and more industries, the world's need for energy grows exponentially. At the same time, the world energy supply is decreasing just as the demand for oil-based energy is increasing. The demand for fuel is overwhelming the world's ability to produce it. That's why now more than ever, it is urgent to understand the energy problem and the available alternatives.

In this book, the author presents the problems and possible solutions in a clear, easy-to-read manner. He begins with a broad overview of electricity, explaining its various mechanisms from electro-mechanical and electromagnetic to thermo-, photo-, and piezo-electric. Energy is defined, and the basics of potential, kinetic, thermal, chemical, and nuclear energy are discussed.

Further chapters cover these topics in greater depth. Readers are introduced to energy sources that draw from such supplies as wind, sun, and water stored in reservoirs. Energy from the ocean—tides, currents, and ocean-heat storage—are also presented. Review questions are provided for each chapter.

Comprehensive listings of Web sites about alternate forms of energy and the organizations devoted to them, plus Web sites relevant to the subject of each chapter, make this an excellent reference resource. The glossary, index, and bibliography are helpful to anyone researching this subject.

Digital Literacy

by Paul Gilster
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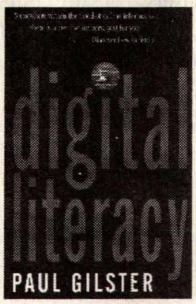

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Using the Internet requires a different way of thinking. Paul Gilster calls this new mindset digital literacy. In his book of the same title, he explains what that mindset entails. He believes that without these new thinking skills, Internet users may be unable to use this medium to its fullest extent.

The book discusses the basic thinking skills needed to thrive in an interactive environment that differs radically from print or television, which are passive media. Internet novices are shown how to evaluate information found in news groups, on bulletin boards, and in other online sources. Readers are taught how to focus search strategies, as well as how to use hypertext and other hypermedia tools. Methods of mapping a path through the wealth of information found on the Internet are explained.

What questions should be asked when viewing a Web site? How do you separate form from content? How to integrate the masses of available information into one's business and personal life? These and other similar questions are discussed in detail.

The author also gives readers a brief glimpse into the future of digital literacy, and he explores other issues such as the question of copyrighting online information.

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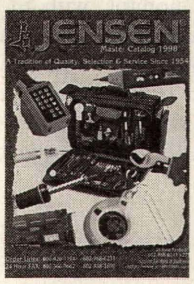

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Jensen's 300-page, full-color Master Catalog is now available. It offers full lines of products for the worldwide electronic/electrical industries. The latest edition contains many new items, organized in a special section, such as power drills, a reciprocating saw, test meters, a stereo inspection microscope, a paging system, multipurpose scissors tool, torx driver sets, and much more.

In addition to Jensen's top-of-the-line tool kits, this catalog covers test equipment; specialty hand tools; wire and cable; power tools and measurement instruments; and devices for soldering, storage, and handling. Among the other products are work stations and static-control sys-

(Continued on page 71)

BUILD A SUPER-SENSITIVE HEAT DETECTOR

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Detect hot or cold objects remotely with this ultra-sensitive infrared-sensing device

Measuring and sensing temperature has resulted in many different methods and devices. While some of the solutions developed meet certain requirements such as temperature range and accuracy, most have some sort of characteristic that makes them unsuitable for the average home hobbyiest.

Sensors such as thermocouples, thermistors, and exotic ICs usually require their own "flavor" of circuitry in order to use their outputs. The outputs are also usually non-linear and change only slightly in relation to the temperature change. The result is a system that can easily be inaccurate because of circuit noise being interpreted as temperature change.

Fortunately for the home experimenter, materials and components are readily available for building an inexpensive non-contact type of temperature sensor that overcomes the limitations listed above. Such a device is presented here. The unit actually indicates the temperature *difference* between the temperature of an object and an arbitrary "ambient" temperature reference that can be set at any time.

A gain control is used to adjust the sensing range from 1° C down to an incredible 0.01° C between the sensor and the ambient reference temperature! While that specification might sound like "design overkill," it is really quite essential for remote sensing. For example, a match flame can be detected up to a distance of one foot at the 1° C gain setting. With the gain increased to detect a difference of 0.1° C, the heat from the palm of your hand can be detected at the same distance. At the maximum gain setting, that same match flame can be detected from across a room!

Obviously, those objects are all more than 1° C hotter than room temperature, so why is such a high gain needed? The culprit is, of course, the "column" of air between the object and the sensor. As the air absorbs and dissipates some of the heat, the apparent temperature falls off rapidly in an inverse-square relationship with the distance—double the distance, and the heat energy drops by a square-root function. By the time the heat reaches the sensor, we are probably sensing convection currents more than the actual direct heat from the object.

The implication is that any air flow will disturb the readings. When using the device at higher gains, still air is the biggest requirement for consistent results. Avoid fans, heat vents, and the like when experimenting. Of course, that "disadvantage" can also become an advantage, expecially when using the unit to *detect* air flow such as "leak" testing.

About the Circuit. As you can see on the schematic diagram in Fig. 1, the actual circuit for the Heat Detector is a deceptively simple design. Remember, however, that the signals involved with sensing a heat source at a distance are very low in amplitude. Low-amplitude signals always run the risk of being lost in the normal background noise that they are sitting in, so all of the components were selected for low-noise performance. For example, notice that all of the fixed resistors are 1% metal-film units. Those types of resistors perform extremely well when low noise is important. What is interesting in the overall design is that the actual values of the resistors are *not* critical—any value within 5% or even 10% of those given should work well. However, the metal-film composition of the resistor is mandatory!

The circuit is a "current mirror" stretched to the ultimate degree. The current mirror itself is built around Q1 and Q2, a pair of surface-mount transistors. The tiny mass of the SOT-23 transistor package lets the circuit respond extremely fast to temperature changes.

A standard current-mirror circuit would only have Q1 and Q2 with their bases and emitters connected in parallel and the base of Q1 shorted to its collector, forming a diode-connected transistor. The current

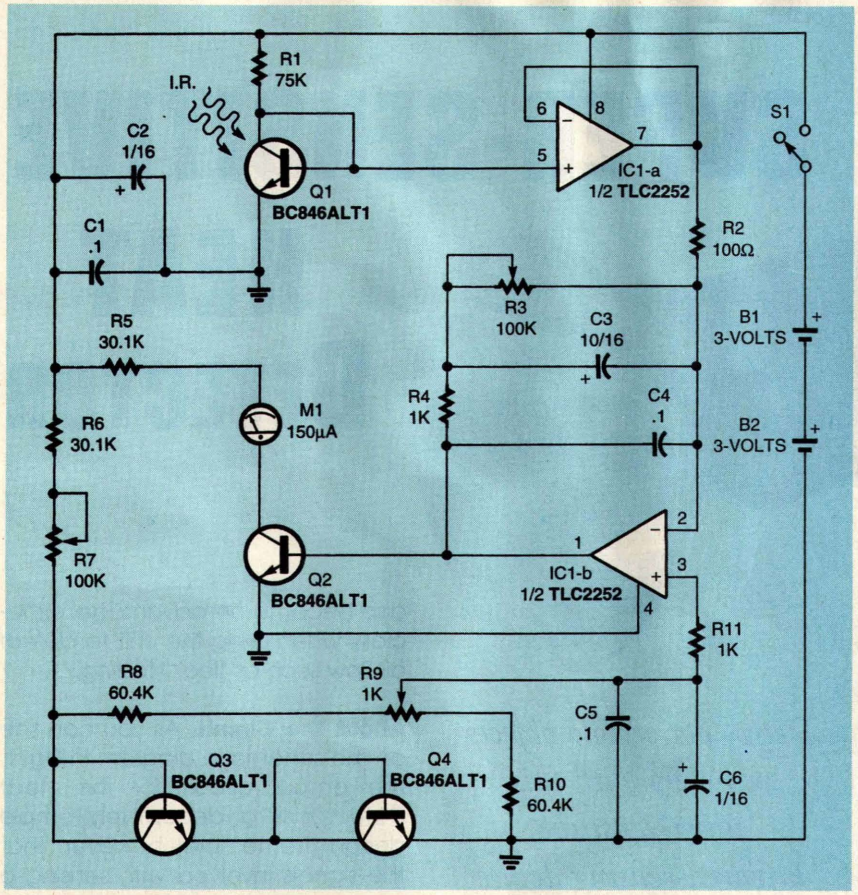

Fig. 1. The Heat Detector is built around a simple current-mirror circuit. When one transistor is heated up, the change in its current flow is reflected in a parallel circuit.

flowing through R1 would then be "reflected" in Q2's collector. For both currents to be equal in size and temperature tracking, Q1 and Q2 are normally a matched pair in a single package. However, the characteristic that we are looking for is the temperature *difference* between Q1 and Q2; that is why individual units are used. For every 1° C increase in the junction temperature of a silicon transistor at a fixed bias current, its forward-bias voltage decreases by about 2 millivolts. By holding Q2 at a fixed ambient temperature, its collector current will decrease as Q1's temperature rises.

A change of only 2 millivolts is not a lot to work with in a remote-sensing circuit, especially if we are interested in displaying a difference of 0.01° C. Besides, an *increase* in current for an increase in temperature would be very desirable.

Placing Q1 outside of the cabinet at the focal point of a standard parabolic flashlight reflector makes the sensor very directional and extremely sensitive to infrared energy focused by the reflector. The rest of the components are located inside a fully-enclosed cabinet that is used as an ambient-temperature reference.

Between Q1 and Q2, a two-stage inverting variable-gain amplifier made up of IC1-a and IC1-b provides the high gain needed for remote sensing. The first stage (IC1-a) is a unity-gain buffer that drives the second stage (IC1-b). The second stage is an inverting amplifier with a gain that can be adjusted between about –10 and –1000 with R3. The audio taper of R3 makes adjusting easy; the most useful gain setting, –100, is at about the center of its rotation.

A 1.2-volt reference, built around Q3 and Q4, tracks temperature changes within the case at a rate of –4 millivolts per degree C. The reference is divided exactly in half, using R8–R10, to a 0.6-volt reference tracking at –2 millivolts per degree C. That output is applied to the reference input of IC1-b. Note that the bias resistors for the transistors have been chosen so that Q1–Q4 all operate at the same current level. That will help ensure that their forward voltages are approximately equal, assuming that they are at the same temperature.

The 0.6-volt reference acts as a "ground" reference for the input signal from Q1. When Q1 heats up by 1° C, its forward voltage decreases by 2 millivolts. With the reference set by R3 to its minimum gain of –10, the voltage appearing at Q2's base and emitter increases by 20 millivolts, which about doubles its collector current. The result is a full-scale display on M1. At a gain of –1000, a 0.01° C increase results in a 20 *microvolt* signal giving a full-scale display! With Q1 at ambient, Q2 conducts enough current for a 50%-of-full-scale display on M1.

As you might suspect, setting the operating levels of the transistors is crucial in order to get any meaningful results out of the instrument. That is done by leaving Q1's current fixed and varying the current to Q3 and Q4 with R7. When adjusting the 1.2 volt reference, R7 can be considered as a "coarse" adjustment. Any "fine" adjustments are then done with R9.

The collector of Q2 directly drives M1, an analog current meter. Although the circuit uses a 150-microamp unit, you can use any analog meter that has a full-scale display between 50 and 250 microamps. Keep in mind that the markings on the meter do *not* indicate any particular temperature reading, just the relative change. If you are going to use a meter of a different capacity, R1, R5, and R6 must be changed in order for the circuit to work. The different values for those components are shown in Table 1 for several different types of meters. Those resistors have been selected to provide current through the transistors so that they all operate at about 50% of M1's full-scale current. The meter is protected from excess current by R5.

The total current drain of the circuit is only about 300 microamperes when M1 is a 150-µA unit. A simple unregulated power supply is quite suitable in that case. Two 3-volt lithi-

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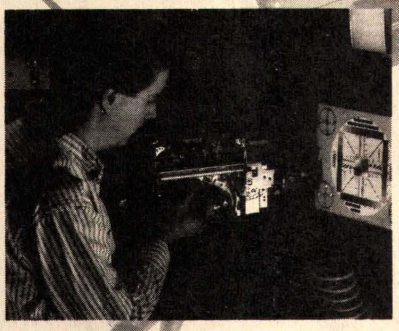

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um coin cells are connected in series for a 6-volt supply. With a rating of about 200 milliamp-hours, they will last a long time. They also have a very "flat" discharge voltage curve, simulating a regulated power supply at those low currents.

One final consideration for this type of circuit is the concern over external noise pickup, such as 60-Hz hum and radio-frequency interference (RFI). Capacitors C1–C6 were specially selected to filter out as much noise as possible while still keeping response times very fast. Tantalum capacitors are highly recommended. If you have noise problems, the values of the capacitors can be increased. You can even connect the parabolic reflector to ground through one of its mounting screws if necessary.

Construction Tips. The Heat Detector's circuit is simple enough that it can be built on perfboard using standard construction technuques. One area that will be a bit more difficult is connecting the tiny surface-mount transistors to the circuit. The simplest method is to attach separate leads directly to the units, converting them to through-hole-like devices. They can then be mounted to a perfboard like any other standard leaded part. The technique is shown in Fig. 2. Use 30-gauge wires that are at least 1-inch long for the leads—the excess length can be trimmed off after the unit is mounted to the board. In order to help protect the transistor from heat-related damage during soldering as well as making it easier to handle the tiny parts, hold the transistor case with a "micro-gator" clip such as a RadioShack 270-373. That particular clip has flat jaws rather than serrated teeth.

Using small tweezers, carefully bend the transistor leads out flat from the case. Wrap a turn or two of wire around the unit's leads with the tweezers. Put the clip in a bench vise and attach another clip to the free end of the wire so that it acts as a weight, stretching the wire. Using very fine solder and a very fine tip on your iron, carefully solder the wire to the lead. Use as little heat as possible for a very brief time in order to avoid damaging the transistor.

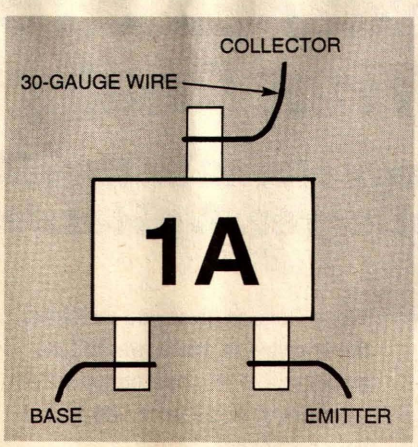


Fig. 2. Surface-mount transistors can be converted to use with perfboard with some careful work.

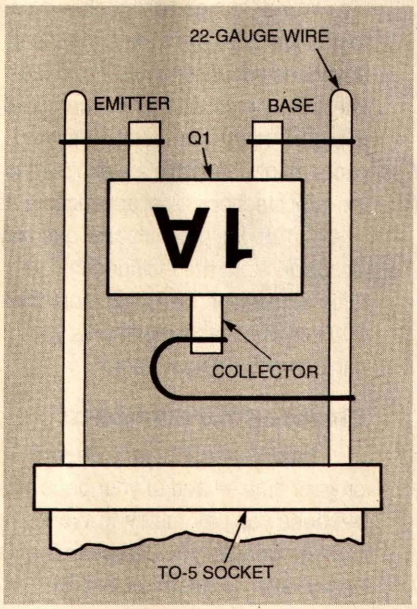


Fig. 3. Transistor Q1 is mounted to a TO-5 socket so that it can be moved to the focal point of a parabolic reflector.

Repeat the procedure for all three leads on all four transistors. Once the solder joints are cool, check the transistors with an ohmmeter to verify that the transistors were not damaged during soldering.

The BC846ALT1 transistors specified for Q1–Q4 are general-purpose NPN small-signal units. Any similar type of device can also be used. Examples of alternate part numbers include BC848ALT1, MMBT3904LT1, and MMBT4401LT1. Note, however, that it is important that all of the transistors are the same device type in order for the correct matching of transistor characteristics. In other words, don't mix and match when selecting parts for Q1–Q4.

When laying out the components on the perfboard, it is a good idea to place R3, R7, and R9 along one side so that their controls point in the same direction. Since R7 and R9 are 20-turn units having only a small adjustment screw, it would be convenient to use some sort of panel-knob adapter for them. Such a device is available from Spectrol for their line of multi-turn potentiometers. Other manufacturers might have similar devices available. The adapters should be mounted to the potentiometers according to the manufacturer's instructions.

Transistors Q3 and Q4 should be installed between R7 and R9 with their cases sitting about ¼-inch above the board for good air circulation around the transistors. Mount Q2 in a similar fashion. Remember that Q1 will not be mounted on the board; it will be discussed later.

Next, select a plastic cabinet that is large enough to hold M1, S1, and the completed circuit board. Cut an appropriate hole for M1; locate and drill the three mounting holes for R3, R7, R9, and S1. The board will be supported by the three potentiometers.

A parabolic reflector from a flashlight or lantern will be used for the collector. Although the size can vary depending on what you have available, a 3-inch-diameter reflector from a 6-volt lantern is a very effective size for the intended use.

Select a transistor socket that will fit through the light-bulb hole at the base of the reflector. A standard TO-5 or TO-39 socket should be fine in most cases. However, it might be necessary to use a smaller TO-18 socket. Install the socket in a hole centered in one end of the cabinet, using silicone sealant to hold it in place if necessary.

Drill a couple of clearance holes through the base of the parabolic reflector on either side of the light-bulb hole for a pair of 2-56 or 4-40 mounting screws. Place the reflector over the transistor socket and mark and drill the screw holes.

Using Fig. 3 as a guide, insert two 1-inch lengths of 22-gauge tinned solid-bus wire into the two widest-spaced holes in the transistor socket. Install Q1 by carefully wrapping its wire leads from its base and

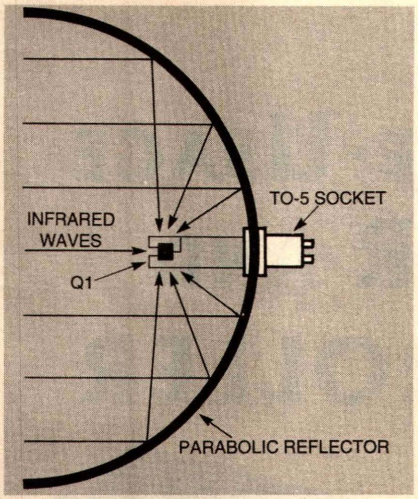


Fig. 4. When Q1 is at the focal point of a parabolic reflector, all of the gathered heat energy will strike the transistor. The size of the reflector will increase the ability of the Heat Detector to collect energy from the source of heat, increasing the gain of the system.

PARTS LIST FOR THE HEAT DETECTOR

SEMICONDUCTORS

IC1—TLC2252 CMOS dual op-amp, integrated circuit (Texas Instruments)
Q1–Q4—BC846ALT1 Surface-mount general-purpose transistor, NPN (see text)

RESISTORS

(All resistors are ¼-watt, 1% metal-film units, unless otherwise noted.)
R1—75,000-ohm (see text)
R2—100-ohm
R3—100,000-ohm potentiometer, audio-taper
R4, R11—1000-ohm
R5, R6—30,100-ohm (see text)
R7—100,000-ohm potentiometer, 20-turn (Spectrol)
R8, R10—60,400-ohm
R9—1000-ohm potentiometer, 20-turn (Spectrol)

CAPACITORS

C1, C4, C5—0.1-µF, monolithic ceramic
C2, C6—1-µF, 16-WVDC, electrolytic
C3—10-µF, 16-WVDC, electrolytic

ADDITIONAL PARTS AND MATERIALS

B1, B2—3-volt lithium battery (CR2032 or similar)
M1—Analog panel meter, 150-µA (see text)
S1—Single-pole, single-throw switch
3-inch parabolic flashlight reflector, enclosure, battery holder, wooden or plastic handle, knobs, shaft adapters for R7 and R9, hardware, etc.

emitter around the 22-gauge wires as shown—do not solder the connections just yet.

Carefully slide Q1 on its leads to about the center of the 22-gauge bus wires. Attach the reflector to the case without disturbing Q1. With everything assembled, Q1 should be at a point close to the focal point of the reflector, similar to the arrangement shown in Fig. 4. It does not have to be exact at this point; we will next be adjusting the assembly's focus. Set the reflector assembly down on a table or bench so that you can look directly down the "business" end of the reflector at Q1.

Starting at a distance of about a foot or two away from the reflector, look at the "image" of Q1 in the reflector. You should see a black "ring" somewhere around the reflector's inside circumference, either towards the front or rear. The black ring is the focused image of Q1's case. If you don't see the ring, try sliding Q1 further in or out and look again; it might take a little practice. What you see should look similar to the view shown in Fig. 5.

Once you see the black ring, move farther away from the assembly while keeping the ring in sight. What you want to end up with is the black ring just about filling the forward (widest) section of the reflector from a distance of around 8 to 10 feet. That is a good focal point for indoor use of the Heat Detector. Slide Q1 in and out a little at a time to achieve that focus.

You can confirm a good focus by pointing the reflector directly at a diffuse light source across the room such as a lamp with a shade or a sun-lit window curtain. Peek over the edge of the reflector, and you should see Q1 glowing like a lamp as the focused light shines on it. DO NOT point the unit directly at the Sun or you might melt or severely damage the transistor!

Once you have a good focus, carefully remove the reflector and solder the base and emitter wire leads of Q1 to the 22-gauge wires. Wrap the collector wire lead of Q1 around the 22-gauge wire connected to Q1's base lead and solder that connection also. Re-check the

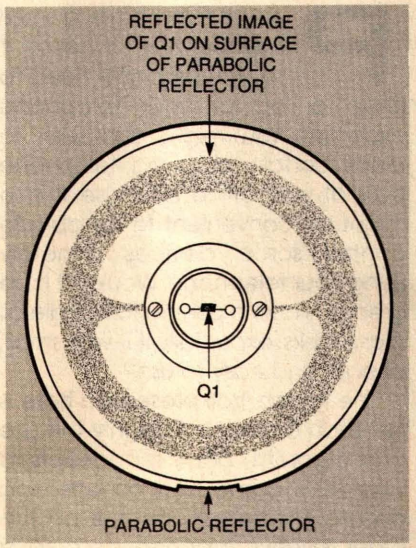


Fig. 5. When focusing Q1, you should see a black band around the surface of the reflector. Careful adjustment of Q1 can vary the apparent size of the reflector to the rest of the circuit.

TABLE 1

ALTERNATE RESISTORS FOR M1

M1	R1	R5	R6
50-mA	215k	90.9k	100k
100-mA	110k	45.3k	49.9k
150-mA	75k	30.1k	30.1k
200-mA	53.6k	22.1k	20k
250-mA	43.2k	18.2k	15k

focal point; if everything looks good, cut off the excess 22-guage wires.

Select a non-metallic handle, such as a plastic or wooden one, and mount it to the opposite end of the case. It is important that the handle not conduct any heat from your hand, or the accuracy of the unit will be affected. If you use a handle from a wood file, the threads in the handle will make it easier to mount the handle to the case.

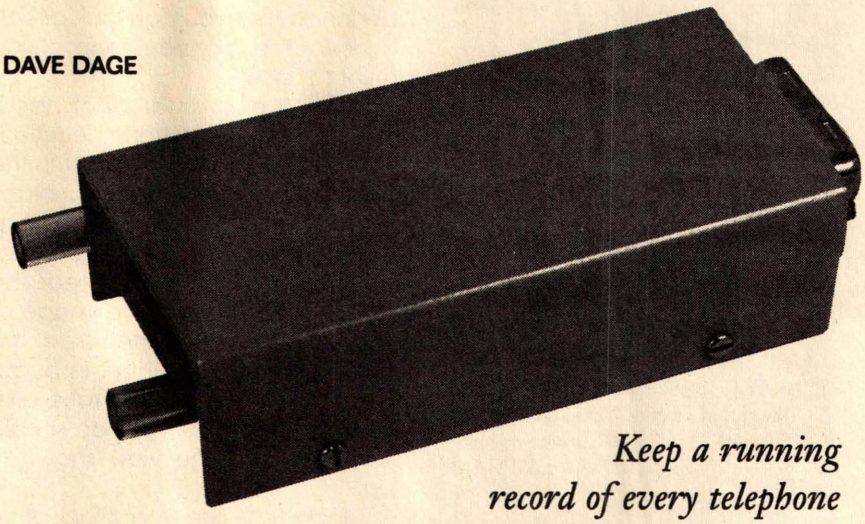
Now you can finish up assembling the Heat Detector. Install the board, S1, and M1, and then wire up the rest of the circuit. If you want to label any of the controls, that should be done before installing any other parts. When wiring Q1 into the circuit, pay careful attention to the polarities of that component.

Install the reflector, the handle, and close up the case. Install the knobs on the potentiometers and set the unit aside for at least 15 minutes to let the temperature inside stabilize after all of the handling it just received. You are now ready to test.

(Continued on page 50)

BUILD A TELEPHONE-USAGE MONITOR AND CONTROLLER

DAVE DAGE



Keep a running record of every telephone call placed or received, or even control other devices with a simple telephone call!

Perhaps you have a small business in your house. If so, you probably need to keep a log of your telephone expenses. You might also wish to block certain outgoing telephone calls at your office or house. It also might be convenient to be able to control some devices remotely using your telephone. Wouldn't it be great to have a device to handle all those tasks, expecially if it was small, cheap, and easy to use?

The Phone Troll presented here is just such a device. Roughly the size of a cigarette pack, it connects to your PC's game port on one end and to the telephone line on the other. It converts phone-line current and DTMF dialing tones into digital signals that are compatible with a game port. With a simple Qbasic program, the Phone Troll can be used for many different tasks.

The "Troll" part of the device's name as used here actually has two meanings. The obvious one relates to the mythical creature that lurks undetected, lying in wait to monitor and record every telephone transaction in your home or business. Information that can be logged each time the phone is used includes the start and end times that the phone was in use, what number was dialed, what dialing buttons were pressed during the call, when an incoming call was received, how many times the phone rang before being answered, and whether or not it was answered.

When the telephone is in use (off-hook), the Phone Troll records all valid DTMF signals—including the additional four tone combinations that are not normally a part of the standard 12-button keypad. This will provide a permanent record of all telephone numbers dialed as well as any other digit activity.

The second meaning of "troll" can be loosely translated into "control". Since the DTMF signals are decoded by a QBasic program, they can be used to signal the program to do some particular task—including control some electrical device connected to the computer's parallel port. The QBasic program is able to detect special control numbers that you can set. By simply lifting the telephone and pressing the proper control code, you can individually turn on and off any of up to eight outputs on the parallel port. To demonstrate that function, a parallel-port monitor plug with light-emitting diodes will also be built.

The control codes used in the Qbasic program are three digits long. When the Phone Troll is active, pressing a three-digit code will turn on or off a single output bit. You can activate the control by simply picking up any telephone that the Phone Troll is connected to, entering a three-digit code, and then hanging up. That feature will also work while talking to someone else. The three-digit code can be entered at any time without disconnecting the call. You can also place a call to your home or office from anywhere in the world, enter the desired control code, and turn an output bit on or off. Of course, the telephone must be answered in order to activate the Phone Troll, but that can be done either by a person or by an answering machine.

Calling home from your car phone just to flip the status of an LED on the back of your computer might not sound like an exciting way to use a pile of expensive high-tech gear. But when the LED is replaced with an opto-isolator acting as a solid-state relay, practically anything electrical can now be controlled by your PC. For instance, turning on a furnace or an air conditioner a couple of hours before you arrive home from a vacation would definitely have some merit. The program listed here needs no modification; it will accomplish all those tasks as written.

One non-obvious use for the Phone Troll is placing the contacts of a single-pole normally-closed

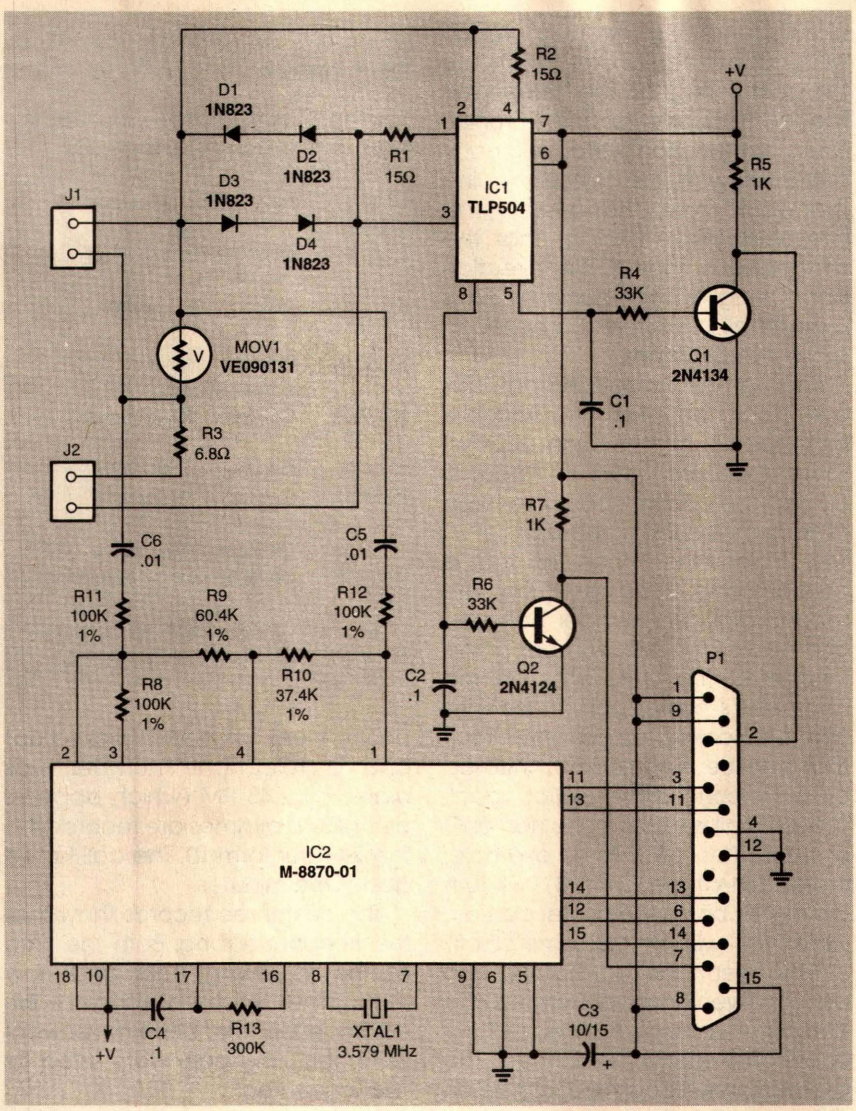


Fig. 1. The Phone Troll is a simple circuit that can sense both telephone usage and DTMF tones. A QBasic program logs activity and can even control other devices.

relay in series with the telephone line. Modify the program to sense the first digit or several digits being dialed on a new call. If the number being dialed starts with a "1" or "1900", activate the relay for a half second. Guess what? That will stop unauthorized persons from using your telephone to place long distance calls or calling any of the "1-900" numbers. The program should also contain a code to enable and disable that function. No one without the proper code would be able to access any long-distance numbers using your telephone.

Note that this arrangement would not be able to prevent operator-assisted calls, unless you also include "0" in the list of numbers on the restricted list. However, doing that is not a good idea—especially as it could be necessary to contact the operator in the event of an emergency.

Yet another use for that "hang-up-the-telephone" technique relates to ordering merchandise from one of those "shop-at-home" TV channels. It's easy to write a QBasic program to test each DTMF digit being entered on the telephone. Have the Phone Troll watch for a string of digits that match any of the family or business credit-card numbers. When one of those numbers is detected, pulse the relay as detailed above. The person will be wondering why the telephone would mysteriously disconnect.

Project Overview. The Phone Troll circuit attaches to the game port on a PC with a standard 15-pin connector. Power for the Phone Troll is supplied by the PC though the game port. The telephone line connects to the opposite end of the Phone Troll through a standard telephone jack. The device is secured to the game port with two mounting screws. Load and run the program, and you're in business.

The Phone Troll has two separate

PARTS LIST FOR THE PHONE TROLL TELEPHONE-USAGE MONITOR

SEMICONDUCTORS

IC1—TLP504 opto-isolator, integrated circuit
IC2—M-8870-01 DTMF decoder, integrated circuit
D1–D4—1N832 silicon diode
MOV1—VE090131 metal-oxide varistor, 38-joule, 130-volt rms
Q1, Q2—2N4124, NPN transistor

RESISTORS

(All resistors are ¼-watt, 5% units, unless otherwise noted.)
R1, R2—15-ohm
R3—6.8-ohm
R4, R6—33,000-ohm
R5, R7—1000-ohm
R8, R11, R12—100,000-ohm, 1%
R9—60,400-ohm, 1%
R10—37,400-ohm, 1%
R13—300,000-ohm

CAPACITORS

C1, C2, C4—0.1-µF, ceramic-disk
C3—10µF, 15-WVDC, electrolytic
C5, C6—0.01-µF, 5%, Mylar

ADDITIONAL PARTS AND MATERIALS

XTAL1—3.579545 MHz crystal, HC49/U case
J1, J2—RJ11 telephone jack, PC-mount
P1—15-pin "D"-style male connector, PC-mount
Case, hardware, etc.
Note: The following items are available from: Dage Scientific, PO Box 144, Valley Springs, CA 95252, Tel: 209-772-2076: Kit of all parts, PC board, and manual (without case or program diskette), No. FT-1, $26.95; Case, No. FT-2, $9.95; Program on 3½-inch diskette, No. FT-3, $2.00. Please add $4.00 for shipping and handling. CA residents must add appropriate sales tax. Visa and Mastercard are accepted on telephone orders.

IC2 can be ordered in single quantities from: ICS, Inc., 2222 E. Camelback Rd. # 222, Phoenix, AZ 85016-3427; Tel: 602-224-5322.

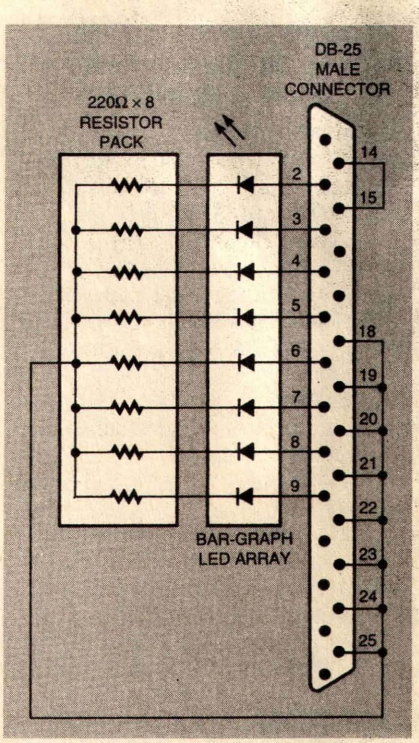


Fig. 2. The test fixture simply connects 8 LEDs to the data lines of a printer port. Connecting pins 14 and 15 together helps the Phone Troll program find the port that the test fixture is connected to.

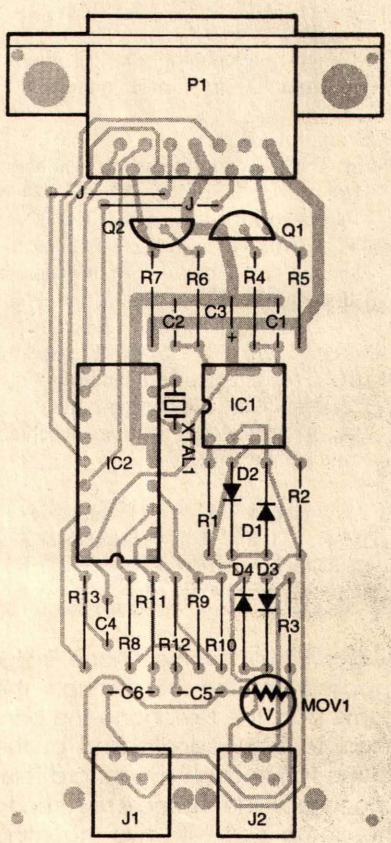


Fig. 3. The Phone Troll fits easily on a single-sided PC board. Only two jumpers are needed.

circuit functions, each of which runs independently. One function is the monitoring of the telephone line continuously for DTMF tones. The other function watches for any current flow in the telephone line that would mean that a telephone has been picked up or that the telephone is ringing. The direction and timing of that current flow is used to tell the difference between those two situations.

The sample program that has been included here also watches for a special combination of DTMF tones that are used as "control codes." The control codes are three digits long. The first number is the "#" key; it alerts the Phone Troll that a control code is being issued. The second digit is a number between one and eight. That number points to one of the data lines on the computer's printer port. Those lines can be hooked up to any circuit that can be electrically controlled by a TTL-compatible digital signal. The last digit is either a one (for "on") or a zero (for "off"). As an example, pressing the three keys "#81" will turn the eighth bit on the printer port on, while "#80" will turn the same bit off.

Any telephone activity will also be displayed immediately on the computer's screen. After each telephone transaction is finished, the information will be saved to a file on disk under the filename "phonelog.txt". That file will be created in the same directory as the QBasic program. Each time the Phone Troll program is started, any additional entries will be added to the end of that text file. Since it is a simple text file, any convenient text editor in either DOS or Windows can be used to view and print the log. The file can be renamed to save it, or it can be deleted. In either case, a new file will be created and the logging started fresh.

An example log file is shown in Listing 1. The appearance is the same on screen and when saved to disk. The first time the program is run, the starting date and time are recorded. After that, just the time is recorded until midnight. At that point, the next record will be preceded by the new date.

In the example, we can see that according to the records, a telephone went "off-hook" (picked up) and a telephone number was dialed at 2:43 PM (which appears as 14:43 as all times are recorded in the 24-hour format). The call lasted about ten minutes.

LISTING 1

Phone log starting 08-16-1997 14:40:57

14:43:08	Off-Hook, DTMF active 7722076
14:53:13	On-Hook - call terminated
16:52:57	Ring - 3 not answered.
17:05:12	Ring - 2 not answered.
17:15:31	Ring - 2 not answered.
17:22:44	Ring - 1 answered. DTMF active - #81#80
17:27:09	On-Hook - call terminated
19:54:39	Off-Hook, DTMF active - #21
19:54:41	On-Hook - call terminated
19:55:53	Off-Hook, DTMF active - #31
19:55:55	On-Hook - call terminated
19:59:18	Off-Hook, DTMF active - #30#20
19:59:22	On-Hook - call terminated

The next three records show that the telephone rang. Both the time of the incoming calls and how many times each call rang are listed. Since the telephone never went "off-hook", the calls were listed as "not answered".

Next, the telephone rang once, was answered, and a control code of #81 was entered, activating the device that is connected to data line 8 on the printer port—let's say that it is a tape recorder whose microphone is connected to the telephone line. Before the call was terminated, control code #80 turned the tape recorder off. That could have been done from any telephone that is monitored by the Phone Troll and not just the one that was picked up for the call. An arrangement like that can be a handy substitute for pencil and paper when a message or important information needs to be saved.

The final three entries are additional demonstrations of controlling devices connected to the computer's printer port from a telephone. First, a lamp connected to bit 2 was turned on. Minutes later, another call turned on the home stereo con-

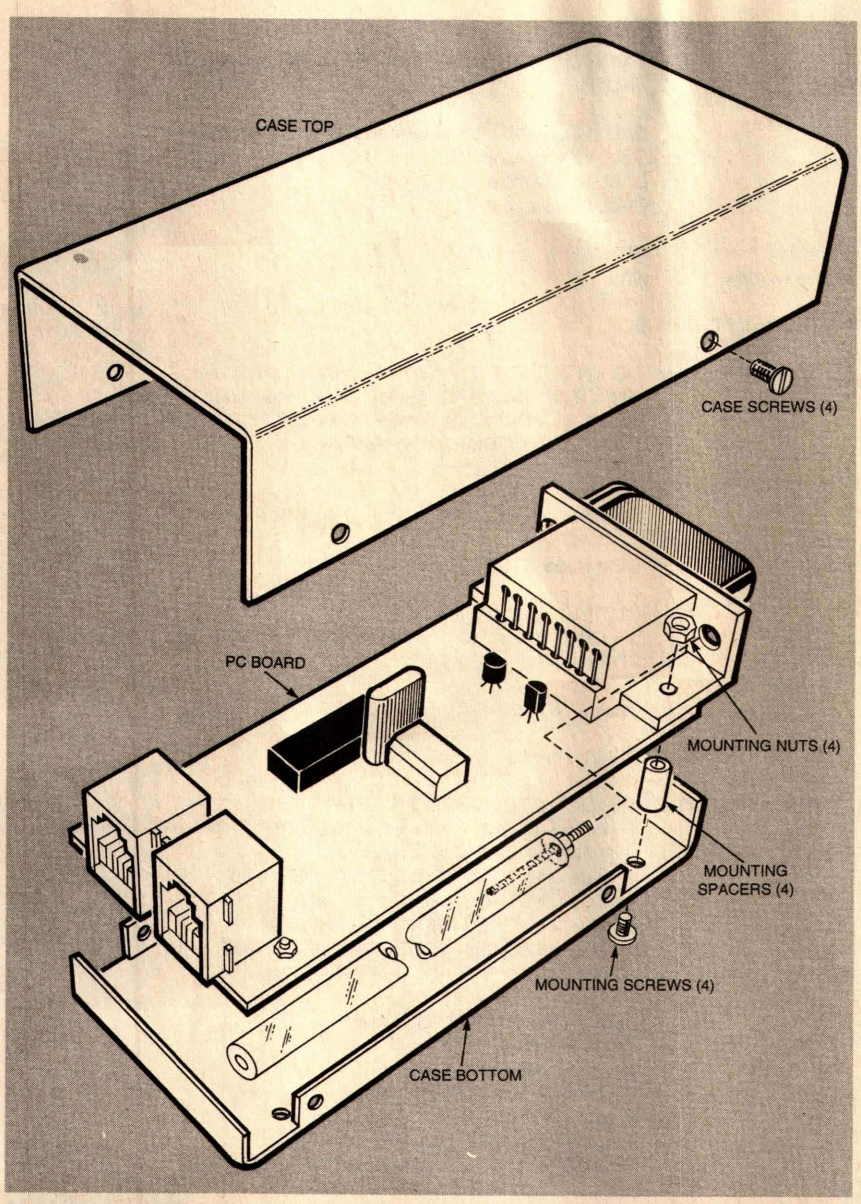


Fig. 4. Placing the Phone Troll in a compact case lets the unit attach directly to the game port on a computer.

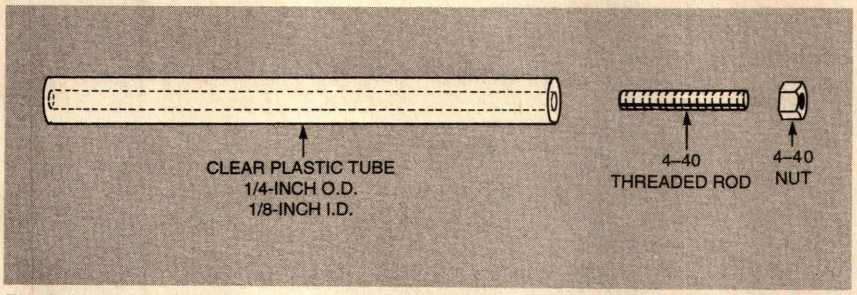


Fig. 5. The special hold-down screws for the Phone Troll are easily made from a piece of plastic tube and a length of threaded rod. You can easily make the threaded rod by cutting off the head from a 4-40 screw.

nected to bit 3. Several minutes later, the final call turned off both the stereo and the light in that order. Understand that any device that can be interfaced to a data line on a printer port can be controlled—lights, heat, air conditioning, or any other device that you can devise a control method for.

Circuit Description. The schematic diagram shown in Fig. 1 reveals how simple the Phone Troll's interface circuit is. Power for the circuit is supplied from the host computer's 5-volt supply through pins 1, 8, 9, and 15 of the game port. Ground is supplied from pins 4 and 12. Telephone jack J1 connects to the telephone line and is surge protected with MOV1. The other telephone jack, J2, is the jack through which the Phone Troll can monitor telephone activity. Any telephones connected to the J1 side of the telephone-wiring system will not activate the Phone Troll. Because of that, the Phone Troll will work best when connected between the telephone company and the telephones in the house—much like connecting additional telephone-line devices to the pass-through connector on a modem, fax machine, or answering machine.

Current on the telephone line is sensed by opto-isolator IC1. Two identical circuits within IC1 sense the current flow depending on the direction that it is flowing. Current flow in one direction will pass through R2 and pins 3 and 4 of IC1 while current flow in the other direction will pass through R1 and pins 1 and 2 of IC1. A wide range of DC current can flow from the telephone's central office, so diodes D1—D4 regulate the current through IC1. The small-signal audio impedance through the diodes and IC1 is matched by R3.

By monitoring the current and its direction, normal telephone activity can be determined. When current flows steady in one direction, the telephone has gone "off hook". On the other hand, current flowing rapidly in both directions means that the telephone is ringing. Typically, the "off hook" pattern is one of current flowing for ½ second in one direction, then switching to the other direction for the remainder of the call.

The second part of the Phone Troll circuit is the DTMF sensing and decoding. DTMF signals fit within the telephone band of 300 to 3000 Hz. Further information on DTMF signals can be found on the Web at http://www.2xtreme.net/dage/dtmf_tut.html.

The DTMF receiver (IC2) is made by Teltone Corp. That chip makes

LISTING 2

```
REM Release version 1.00 Date 10/16/97
REM No global variables, auto detection of output plug

DECLARE SUB OneSecTD ()
DECLARE SUB FindPort ()
DECLARE SUB LineSample ()
DECLARE SUB Ring ()

REM ratio = time current flows in one direction, divided by
REM time current flows in other direction during sample window.

REM The DATA below are the normal addresses for LPT1 to LPT3 in
    decimal.
REM Add additional output port (in decimal) to DATA, ending with 0 only.
REM "SUB FindPort ()" will read DATA below
DATA 888,632,956,0

CLS
CALL OneSecTD ' initialize
REM BEEP
REM PRINT "OneSec = "; OneSec; " FOR/NEXT loops"
REM FOR t = 1 TO OneSec: NEXT t ' wait one second
CLS
CALL FindPort

CLS

RecordDate$ = DATE$

OPEN "PHONELOG.TXT" FOR APPEND AS #1

PRINT #1, "Phone log starting "; RecordDate$, TIME$: PRINT #1, :
PRINT #1,
PRINT "Phone log starting "; RecordDate$, TIME$: PRINT : PRINT
CLOSE #1

inactive: '////////// START LINE MONITORING //////////

ringct = 0: noanswer = 0: incoming = 0      'initialize

DO
CALL LineSample
LOOP WHILE ratio = 9 'no current, ratio =9


CALL LineSample 'get fresh reading
IF ratio = 9 THEN GOTO inactive 'glitch remover

REM Phone line now active - either off-hook or ring

OPEN "PHONELOG.TXT" FOR APPEND AS #1

IF RecordDate$ <> DATE$ THEN 'Prints date once each day.
 RecordDate$ = DATE$
 PRINT #1, "Phone log for", RecordDate$: PRINT #1, : PRINT #1,
 PRINT "Phone log for", RecordDate$: PRINT : PRINT
END IF

PRINT #1, TIME$,
PRINT TIME$,

IF ratio > .5 THEN incoming = 1: CALL Ring

CallHandeling:

IF incoming = 0 THEN
 PRINT #1, "Off-Hook, DTMF active - ";
 PRINT "Off-Hook, DTMF active - "; 'DTMF digits displayed here
 ELSEIF noanswer THEN
 PRINT #1, "Ring - "; ringct; " not answered."
 PRINT #1, : CLOSE #1
 PRINT "Ring - "; ringct; " not answered.": PRINT : GOTO inactive
 ELSE
 PRINT #1, "Ring - "; ringct; " answered. DTMF active - ";
 PRINT "Ring - "; ringct; " answered. DTMF active - ";
 END IF

 CALL LineSample 'used for delay when phone lines switch
 CALL LineSample
 CALL LineSample
 CALL LineSample

 REM ////////// start DTMF //////////
 dtmf:

 DO

 DO UNTIL INP(513) AND 128 'loops until next digit
 IF (NOT INP(513) AND 48) = 0 THEN 'exits when on-hook
 PRINT #1, : PRINT #1, TIME$, "On-Hook - call terminated": PRINT #1,
 PRINT : PRINT TIME$, "On-Hook - call terminated": CLOSE #1
 PRINT : GOTO inactive
 END IF
 LOOP

 REM Read DTMF

 OUT 513, 0 'start one-shots
 n = INT(OneSec * .01) 'wait 10 mSEC
 FOR t = 1 TO n: NEXT t

 value = NOT INP(513) AND 15

 REM //// print all 16 valid DTMF codes ////

 IF value = 0 THEN PRINT "D"; : PRINT #1, "D";
 IF (value > 0) AND (value < 10) THEN PRINT CHR$(48 + value); :
    PRINT #1, CHR$(48 + value);
 IF value = 10 THEN PRINT "0"; : PRINT #1, "0";
 IF value = 11 THEN PRINT "*"; : PRINT #1, "*";
 IF value = 12 THEN PRINT "#"; : PRINT #1, "#";
 IF value > 12 THEN PRINT CHR$(52 + value); : PRINT #1, CHR$(52 +
    value);

 REM //// Start Control Application ////
 IF bas% THEN
 contdig = value
 IF contdig = 10 THEN contdig = 0
 IF cont = 1 THEN s = s + 1
 IF s = 1 THEN addr = contdig
 IF s = 2 THEN dta = contdig: s = 0: cont = 0: doit = 1

 IF contdig = 12 THEN cont = 1

 IF doit = 1 THEN
 op = 2 ^ (addr - 1)
 IF dta = 1 THEN
 outreg = outreg OR op
 ELSE
 op = op XOR 255
 outreg = outreg AND op
 END IF
 OUT (bas%), outreg
 doit = 0
 END IF
 END IF
 REM //// End Control Application ////

 DO WHILE INP(513) AND 128 'loops until digit gone
 IF (NOT INP(513) AND 48) = 0 THEN 'exit when on-hook
 PRINT #1, : PRINT #1, TIME$, "On-Hook - call terminated": CLOSE #1
 PRINT : PRINT TIME$, "On-Hook - call terminated"
 PRINT : GOTO inactive
 END IF
 LOOP
LOOP

END
```

designing a DTMF-receiver circuit very simple because all of the processing is performed on-chip. All that is needed for operation is a power supply, the audio signal, a timing crystal, and adjusting the guard time.

An AC-balance connection is made to the telephone line through C5 and C6. Precision resistors R8–R12 provide the balance network to IC2—it is important to balance both sides of the telephone line with respect to the op-amp portion of IC2. A 3.579545-MHz color-burst crystal, XTAL1, is directly connected to pins 7 and 8 of IC2. All of the necessary drive circuitry is internal with no external components needed. The guard time is set by R13 and C4. The values listed set the valid length for the "tone-present" and "tone-absent" timing to 40 ms. Those values should work perfectly; they can be adjusted if needed.

When a valid tone pair has been detected, the four-bit binary code that represents that tone pair appears on output pins 11–14. Pin 15 also goes high for 40 ms as a signal that the data on the output lines is valid and stable. That feature is very important in order to be able to use the game port in such a nontraditional manner.

An IBM game port has 8 inputs—

LISTING 3

```
SUB FindPort
SHARED OneSec
SHARED bas%

READ bs

DO
 test1 = 0: test2 = 0
 OUT (bs + 2), 4
 IF INP(bs + 1) AND 8 = 8 THEN test1 = 1
 OUT (bs + 2), 6
 IF NOT INP(bs + 1) AND 8 THEN test2 = 1
 IF test1 AND test2 THEN bas% = bs
 READ bs
LOOP WHILE bs

IF bas% = 0 THEN
 BEEP: PRINT "Test plug not found. Press  any key to enter address,"
 PRINT "or, wait for program to start without the control function.": PRINT : PRINT
 REM loop is about three times as long as  OneSec
 DO WHILE INKEY$ = "" AND t < 3 * OneSec
 t = t + 1
 LOOP
 IF t < 3 * OneSec THEN
 INPUT "Enter output port address in decimal."; bas%
 ELSE EXIT SUB
 END IF

ELSE PRINT "Base address = ";
HEX$(bas%); " HEX, or decimal"; bas%

REM Cycle output LEDs
 FOR n = 1 TO 3
 OUT bas%, 255: BEEP: FOR t = 1 TO OneSec / 5: NEXT t
 OUT bas%, 0: FOR t = 1 TO OneSec / 10:
NEXT t
 NEXT n
END IF

END SUB
```

LISTING 4

```
SUB LineSample
SHARED ratio

la = 0: lb = 0: LoopStartTime = TIMER
DO WHILE (TIMER - LoopStartTime < .2)
 IF NOT INP(513) AND 16 THEN la = la + 1 'check bit 4, active low
 IF NOT INP(513) AND 32 THEN lb = lb + 1 'check bit 5, active low
 REM correct LoopStartTime when passing thru midnight
 IF (TIMER - LoopStartTime < 0) THEN LoopStartTime = LoopStartTime - 86400
LOOP

IF la = 0 AND lb = 0 THEN 'Ideal samples
 ratio = 9 ' ratio = 9 Assigned; Line is calm
 ELSEIF la < lb THEN ' ratio = 1 Active Ring
 ratio = la / lb ' ratio = 0 Off-Hook
 ELSE ratio = lb / la
END IF

END SUB
```

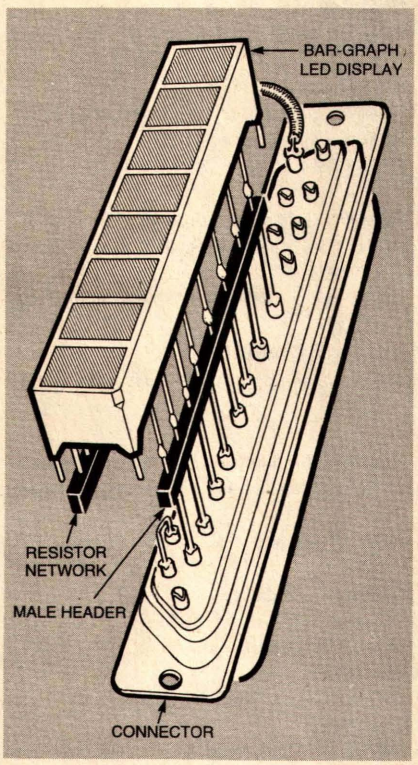


Fig. 6. The finished test fixture will look something like this. A straight-pin header helps connect the bar-graph display to the connector. The pins on the header will have to be spread to match the spacing on the header.

4 analog and 4 digital. Three of the digital inputs are used—two for the telephone-current sensing, and one for the "DTMF valid" signal. The data lines from IC2 are connected to the analog inputs. Here is where the "non-traditional use" comes into play. The DTMF data signals are connected to an individual resistor/capacitor circuit in the game card hardware that is used to control the pulse width of a one-shot multivibrator. If the digital signal is high, the one-shot times out fast; if the digital signal is low, the one-shot takes a long time to time out (if at all).

Since the DTMF signals are locked for at least 40 ms, that leaves enough time for the QBasic program to check the "joystick button" that indicates that DTMF data is available. The program reads the analog "joystick position" by triggering all four multivibrators. After a certain amount of time, the state of the one-shots are read out. The time period between triggering the one-shots and reading their state is long enough to give them time to time out if they are sensing a high signal, but not long enough to let them time out if they are sensing a low signal. Although it sounds complex and exacting in terms of critically-timed events, there is a wide margin available, making the readings very reliable. The QBasic program can accomplish those steps with time to spare.

Output Test Fixture. As mentioned before, the Phone Troll can control devices attached to the printer port. While the actual interface circuits are beyond the scope of this article, some way is needed to verify that the Phone Troll can actually send signals to the printer port. A simple test fixture is shown in Fig. 2. It is simply a set of 8 light-emitting diodes connected to the data lines of the port. A set of resistors limit the current through the LEDs, and the circuit is completed through the port's ground lines. With that arrangement, the LEDs can be lit individually with the control codes.

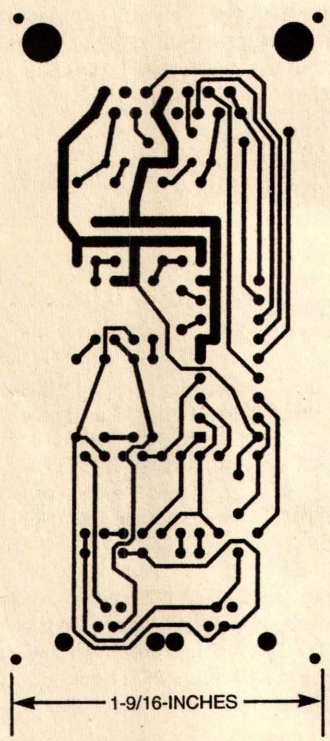
Lighting LEDs might not sound very exciting, but the LEDs can be replaced with any type of opto-isolator chip. Those chips can have different types of circuits on their output sides. Readily-available outputs include bi-polar transistors, silicon-controlled rectifiers, and Triacs.

LISTING 5

```
SUB OneSecTD
SHARED OneSec

REM Purpose:
REM To find the number of FOR/NEXT loops on a specific computer to cause
REM a one second delay, variable [OneSec] is number of loops/second.

REM Use:
REM For program delays > 3 mSEC to < 500 mSEC. Interrupts affect accuracy.

REM Example:
REM To delay 250 mSEC, insert this code:
REM n = INT(OneSec * .25)
REM FOR t = 1 to n : NEXT t

REM **** Calibrate host cmptr / Turbo must remain constant ****
PRINT "Calibrating FOR/NEXT delay loops. Please wait."
x = TIMER
DO WHILE x = TIMER: LOOP 'Wait until new clk tick
x = TIMER
 DO UNTIL TIMER - x >= .5
 n = n + 1 'see how many n's for half second
 LOOP

REM n is the number of do/loops in half sec. estimate for/next is 6X faster
n = n * 24 'should be close to 2 second delay

REM **** test and trim n for a 2 sec delay ****

lastloop = 2 'initialize
DO
 n = n * 2 / lastloop
 x = TIMER
 DO WHILE x = TIMER: LOOP
 x = TIMER
 FOR t = 1 TO n: NEXT t
 lastloop = TIMER - x
LOOP WHILE lastloop < 1.9 OR lastloop > 2.1
OneSec = INT(n / 2)

END SUB
```

Construction. The Phone Troll is a simple project to build. All of the components are mounted on a single-sided PC board. A foil pattern has been included for those who wish to etch their own board. As an alternative, a kit with a pre-etched board is available from the source given in the Parts List.

If you are building the kit or using



Here's the foil pattern for the Phone Troll.

LISTING 6

```
SUB Ring
SHARED ratio
SHARED ringct
SHARED noanswer

RINGADING:

DO
 CALL LineSample
LOOP UNTIL ratio < .5 OR ratio = 9 'loops while ringing, but may catch first silence

ringct = ringct + 1
CALL LineSample 'get full sample

REM ring has either stopped (ratio = 9) or phone goes off-hook (ratio < .5)
REM assume between rings, then check for off-hook

RingStartTime = TIMER

DO WHILE TIMER - RingStartTime < 5  AND ratio = 9
 CALL LineSample
 REM correct RingStartTime when passing thru midnight
 IF TIMER - RingStartTime < 0 THEN RingStartTime = RingStartTime - 86400
LOOP

CALL LineSample

IF ratio > .5 AND ratio <> 9 THEN GOTO RINGADING 'ring again
IF TIMER - RingStartTime >= 5 THEN noanswer = 1

END SUB
```

the included foil pattern, use the parts-placement diagram in Fig. 3 for locating the various components. Note that two jumper wires are needed; they are located near P1. When mounting the components, pay careful attention to the orientation of the semiconductors. The 1% resistors have three digit bands instead of two. The values, however, can still be read using the standard color codes.

The assembled board can be enclosed in a suitable case and mounted to the game port as shown in Fig. 4. With that arrangement, you will need to make a pair of extended screws for securing the Phone Troll to the game-port connector. Take a suitable length of stiff plastic pipe that is hollow. Glue a length of 4-40 threaded rod in one end so that it sticks out enough to screw down P1 to the game port. A nut should be threaded onto the rod to act as a stop. The length of the plastic pipe should be long enough to reach out the back of the case. That way, the screw can easily be turned by hand. The details for the extended screw are shown in Fig. 5. If you do not want to mount the Phone Troll like that, you can install it in a receptacle box and connect it to the game port with a cable and 15-pin "D" connector.

The test fixture can be made from an eight-LED bar-graph display, a single-inline resistor network, a 25-pin connector, and a strip of single-row straight header. The header will need to be bent on one side to match the spacing of the connector. That method makes a rugged assembly that matches up the different pin spacings between the connector and the bar-graph display.

Don't forget to install a jumper between pins 14 and 15 on the connector. The QBasic program will check all of the available parallel ports. The jumper will help identify the connector to the program. The completed fixture will look similar to the one shown in Fig. 6. As a side note, the test fixture can also be used as a stand-alone test tool. You can use it to automatically find, identify, and test an active parallel port including enhanced parallel ports.

Testing the Phone Troll. Connect the telephone lines to the Phone Troll and attach it to the PC's game port. Plug the test fixture into the printer port. The QBasic program will have to be typed in—follow Listing 2 through Listing 6 in order. Save the program as "FONETROL.BAS". Run the program, and the Phone Troll is up and running. If you aren't using the test fixture, the program will pause to let you set the parallel-port address. If no address is entered, the program will continue but without the control function.

After the program checks your computer's speed (for the timing function) and determines which parallel port is active, it will display the date, time, and start a log file. Pick up a telephone and the screen should show "Off-Hook, DTMF active". Press #11 through #81 and all eight LEDs should turn on one at a time, depending on which LED you're activating. Press #10 through #80 and all eight LEDs should turn off.

When building a new device, there's always the possibility that it won't work the first time. Recheck all of the parts for correct placement, orientation, and solder connections before continuing. Troubleshooting is more of an art form than a science and can't easily be explained in a few paragraphs. However, here are a few test points to check that will help isolate any trouble spots in the circuit. When the telephone goes off-hook, the voltage at R7 (next to Q2), or voltage at R5 (next to Q1) will drop from 5 volts to less than 1 volt. With a high-impedance device such as an oscilloscope or logic probe, verify that the oscillator at pin 8 on IC2 is running. Pick up a telephone that is being monitored by the Phone Troll and press a button. You should see that pin 15 on IC2 pulses low. Those tests will help pinpoint any spots in either the circuit or the software for additional tests.

Programming in QBasic. A nice feature with QBasic is that you are not restricted to the original program as would be the case with a compiled executable program. Running the Phone Troll directly from the source code lets you customize the Phone Troll's features to your own wants, needs, and desires. You will still need

to know how to program in QBasic, but it's very easy to modify the code and see what happens. Many budding programmers start gaining hands-on experience by modifying a program to achieve a particular goal. Just make sure that you have a backup copy of the program before you start experimenting. The program is well documented and will stand alone to act as a guide for those who are familiar with QBasic.

One example of a need to modify the program has to do with distinctive-ring service. The program will detect and count a normal ring cycle (two seconds of ringing followed by four seconds silence). Distinctive ringing might cause the Phone Troll to count each burst of rings, indicating two or three rings for each actual ring. Simply divide the variable *ringct* by two or three, or rewrite the program to indicate which sequence of rings was received.

Like any good servant, your troll awaits. Ω

HEAT DETECTOR

(continued from page 41)

Using the Heat Detector. There are a few points to consider whenever using the Heat Detector to obtain consistent readings: always grasp the unit by the handle only, keeping your body heat as far away from the cabinet as possible. For critical operation, attaching the unit to a camera tripod would be an excellent method.

Unless you are actually leak-testing and looking for circulating air, any air that blows across Q1 will cause temperature drift in your readings. Still air is the priority here.

The parabolic reflector used is very directional and will take some practice in aiming. Pointing a standard flashlight at an opposite wall will give you an idea of the area of coverage to be expected.

Hold the unit by the handle and set R3 to its *minimum* gain setting. Set R7 and R9 to their mid-positions. Turn on the power and point the reflector at a blank wall.

Adjust R7 for a display of about half of full scale on M1. That is the most sensitive area, although any region between 20% and 80% will work well. If R7 won't get you on scale, it might be necessary to adjust R6's value. An increase in value lowers M1's reading, and vice versa.

Advance R3 slowly while watching the display—it will probably move off-scale in one direction or the other as you arrive at the maximum gain setting. That is due to inherent offset voltages in the components. Adjusting R7 should give full-scale coverage in either direction at the highest gain setting. If not, adjust R6's value as mentioned above.

Note that making any settings with R7 becomes more difficult as the gain is increased. That is where R9 becomes very useful. For best results, always adjust R7 first to get as close as possible; then use R9 as a "fine" adjust for a 50% of full-scale indication on M1.

Set R3 back down to its minimum gain setting and adjust R7 for a 50% reading on M1. Now that you have an ambient-temperature set-point from the blank wall, point the unit at a match or candle flame about 6 to 12 inches away. You should immediately "peg" M1. Return to the blank wall and the display will return to 50%.

Rotate R3 to mid-position, and adjust R7 for a 50% reading on the blank wall. Hold the palm of your hand about 6 to 12 inches in front of the reflector and M1 should go full-scale again. Hold an ice cube in front of the reflector and M1 should drop to its minimum reading.

Rotate R3 to its maximum position, and adjust R7 (followed by R9) for a 50% reading on the blank wall. Now you can "sweep" slowly around the room. A hot spot such as a sun-lit window or a lamp will probably peg M1 at full-scale. You will now note that any breeze, even one caused by rapid movement of the Heat Detector, will cause display drift!

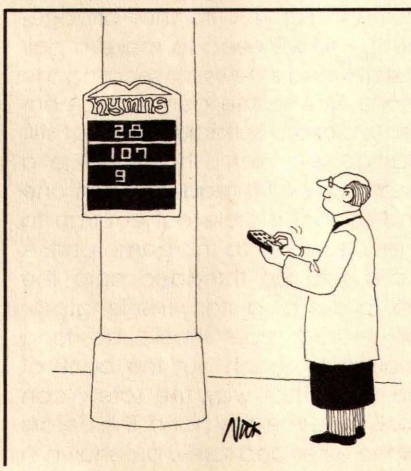
Going Further. You will by now have realized that the parabolic reflector plays a critical role in the sensitivity and area of coverage of the Heat Detector. A 3-inch-diameter reflector is an excellent size for general-purpose use. However, it can be difficult to aim accurately at distant objects.

The solution to that problem is to use a larger reflector. Any photographic supply store will carry larger-diameter reflectors. Of course, the sensitivity of the instrument increases with the square of the diameter in addition to the coverage.

Some applications such as remote testing of circuit boards for hot spots might have the opposite requirement—miniature parabolic reflectors. A 1-inch-diameter reflector would be highly directional. The Heat Detector has sufficient gain to compensate for the decreased gain from the reflector. A miniature flashlight would be a good source for smaller reflectors.

Of course, you still have to make sure that Q1 is focused properly. An adjustable focus arrangement would be a great help in close-up work, where the focal point moves further away from the rear of the reflector. One method that can be used to make the Heat Detector more versatile would be to use a TO-5 transistor socket with female pins that are spring-loaded and completely hollow through their length. That would allow you to slide Q1 back and forth to achieve any focus position.

The Heat Detector is an easy-to-build precision instrument that shouldn't cost more than about $25 to put together even using all new parts. Any salvaged or surplus components will drop the cost of the project to the point where it becomes an almost trivial matter to add such an instrument to your bench or tool kit. Build one yourself and have hours of educational fun, or even put it to some practical use! Ω



MAKE YOUR OWN SHUNTS!

While they might not be as accurate as the commercial units, these easy-to-make shunts are more than sufficient for many uses, and cost far less.

DEAN F. POETH II, Ph.D., K8TM

Using a modern multimeter to measure current can sometimes be difficult. Many of these meters will only measure up to one amp. However, many 12-volt DC-powered projects draw a lot more than that. If you have ever thought of purchasing a commercial shunt to solve the problem, you know just how expensive they can be. Commercial shunts, while very precise, frequently cost more than the projects they are measuring!

However, there is a better and cheaper alternative that will work perfectly well in most situations: With only a few cents worth of wire and a little know-how, you can make your own shunts. It only takes a few minutes, and it's fun!

What Is A Shunt? A shunt is simply a resistor of very low value (frequently less than one ohm) that is used to help measure current. As shown in Fig. 1, the shunt resistor R_{SH} is placed in parallel with a meter to decrease its sensitivity by a known amount. The shunt does that by bypassing or "shunting" most of the current around the meter. The shunt resistor therefore lets you take a standard meter, such as a 0–1 milliammeter, and turn it into, say, a 0- to 20-amp meter.

The Shunt Meter. Before you can make a shunt, you must find a suitable shunt meter. Surplus analog meters can be found at hamfests or mail-order sources for only a few dollars each, and they make excellent shunt meters. For a list of mail-order sources of surplus analog meters, as well as new ones, see the sidebar.

When selecting a meter, try to pick a 0–1 milliammeter in good physical condition and one with a convenient scale on the faceplate. For example, if you need the meter to read 10-amps full scale, then select a meter graduated from 0 to 1. If you need a full scale reading of 30 amps, select one with a 0 to 3 graduation.

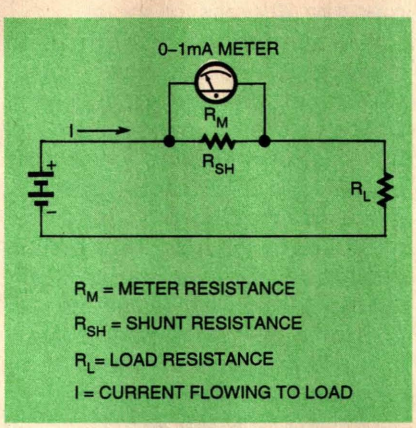


Fig. 1. A shunt is simply a resistor of very low value (frequently less than one ohm) that is used to help measure current. It is placed in parallel with a meter to decrease its sensitivity by a known amount.

To make a shunt, you will need to know the internal resistance of your meter. Therefore, select a unit that has its internal resistance printed on it, most likely in small letters on the meter face or on the back near the terminals.

If you already have a meter on hand but do not know its internal resistance, there is a simple way it can be determined. If you have a modern *digital* multimeter, set it to its highest resistance range. Connect the multimeter's red (positive) lead to the positive analog meter terminal and the black (common) lead to the analog meter's negative terminal.

Digital multimeters measure resistance by passing a small amount of current through the device under test. Do not attempt to use an *analog* multimeter to make this measurement. These older multimeters use much more current to test resistance, enough to potentially destroy some milliammeters

Watching your analog meter, work your way down the DMM's resistance ranges (remember you began at the highest range) until the analog meter's needle moves to a full-scale reading. Note the reading on your DMM, and write it on the back of the meter using a permanent marker. Be careful and take your time. If you go too fast and accidentally pin the meter, it could easily be damaged.

Making The Shunt. The shunt is made from a short length of copper wire. All wire has resistance, so we can use that property to make a shunt resistor. To make the shunt, you first need to determine how much current will flow through it. For example, if your meter is going to measure 20 amps full scale, then the shunt wire must be safely able to carry that amount of current.

Let's say you are going to make a 20-amp shunt using a surplus analog 0–1 milliammeter whose faceplate is graduated from 0–1. Go to a copper-wire table (there is one in the *ARRL Handbook for Radio Amateurs*; if you don't have a copy, it is available at almost any public library) and select an appropriate gauge wire. Remember that the smaller the wire gauge, the larger its diameter and the more current it can safely carry. For most hobby applications, 250 circular mils per amp is more than adequate.

To find the circular mils per amp for the shunt wire, divide the circular mils for the selected wire (found in the copper wire table) by the

Surplus and New Analog-Meter Suppliers

All Electronics Corp.
P.O. Box 567
Van Nuys, CA 91408-0567
Tel: 800-826-5432

Digi-Key Corp.
701 Brooks Ave. South
P.O. Box 677
Thief River Falls, MN 56701-0677
Tel: 800-344-4539

Fair Radio Sales Co.
P.O. Box 1105
1016 E. Eureka St.
Lima, OH 45802
Tel: 419-223-2196

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2401 Highway 287 North
Mansfield, TX 76063-4827
Tel: 800-346-6873

RadioShack
Stores nationwide

The Electronic Gold Mine
P.O. Box 5408
Scottsdale, AZ 85261
Tel: 602-451-7454

current you intend to pass through the wire:

Circular Mils per amp = (circular mils for wire)/(current through the wire) (Eq. 1)

By using the copper wire table, you will find that 12-gauge wire has a cross-sectional area of 6530 circular mils. By dividing that by 20 amps, we get 326 circular mils/amp, which should work fine. Twelve-gauge wire is very common, and can be purchased in most hardware stores.

To find the resistance of the shunt, use this equation:

$$R_{SH} = R_M / (n-1) \quad \text{(Eq. 2)}$$

Where R_{SH} is the resistance of the shunt, R_M is the resistance of the surplus meter, and n is the shunt's multiplication factor. In our example, since we are using a 0–1 milliammeter and 1 milliamp = 0.001 amps, n = 20 amps/0.001 amps, or 20,000.

Next, let's suppose that the resistance of your meter was 81 ohms. Plugging that resistance and n = 20,0000 into Equation 2 yields:

$$R_{SH} = 81V/(20{,}000\text{-}1) = 0.00405V$$

That's not very much resistance, is it! A shunt having that resistance will pass 19.999 amps thought it, and 0.001 amps (1 mA) will pass through the meter for a full-scale reading.

Next, we need to calculate the length of our shunt. Note that as stated in the copper-wire table, 12-gauge wire has a resistance of 1.619 ohms/1000 ft. Therefore, the length of the shunt wire (L_S) can therefore be determined using:

$$L_S = R_{SH}/(XV/1000\ \text{ft.}) = 0.00405/(1.619V/1000\ \text{ft.}) = 2.5\ \text{ft.}$$

So the 12-gauge wire shunt should be 2 feet 6 inches long when using a 0–1 mA meter having an internal resistance of 81 ohms to measure 20 amps full scale.

If we made the shunt this long, however, we might have trouble with contact resistance. That is because even a good solder joint has a lot of resistance when compared to a 0.00405-ohm shunt. To make sure that the circuit's contact resistance is not part of the shunt resistance, two *sense* wires are used. These sense wires are spaced L_S apart on the shunt wire as shown in Fig. 2. Any type of wire may be used for the sense wires; they are noncritical. This simple feature will greatly increase the accuracy of your shunt.

Now we are ready to make our shunt. Cut a length of 12-gauge solid copper wire about 3-feet long. Remove the insulation from the wire using a hobby knife, being careful not to nick it. Now measure about 2 inches from one end and solder one sense wire there. Carefully measure 2 ft 6 inches from that sense wire and solder the second sense wire in position. Connect the shunt to its meter as shown in Fig. 2, and you're ready to measure current! If you want to make the shunt a little more compact, you can wind it over an insulated screwdriver handle or something similar such as a non-conductive wood dowel.

Calibrating the Shunt. Shunts made using this method can be very accurate. However, improved accuracy can be achieved by calibrating the shunt to a known standard, *i.e.*, a calibrated meter. To do this, build the circuit shown in Fig. 3. Make sure that the load resistance, R_L can safely handle the power. I have found that car taillight lamps make a convenient load for the circuit.

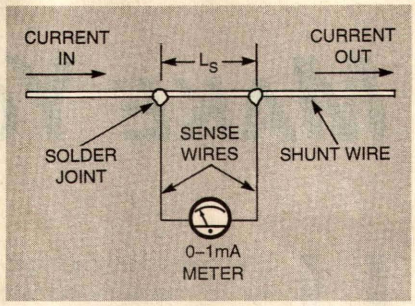


Fig. 2. Two sense wires can be used to make sure that the circuit's contact resistance is not part of the shunt resistance.

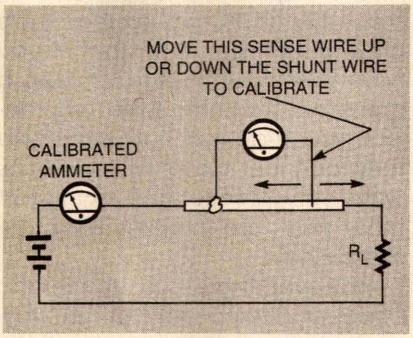
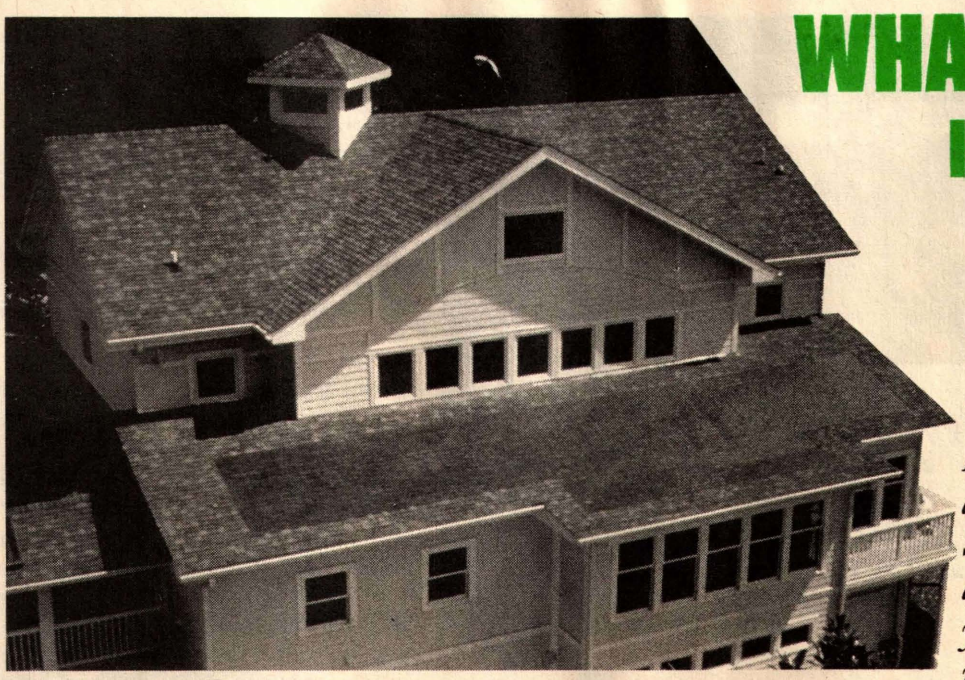


Fig. 3. To make sure that your shunt is as accurate as possible, this setup can be used. An automobile taillight lamp is a good candidate for the load resistance.

To calibrate the shunt, solder one sense wire into position as described above. Power up the circuit and slide the second sense wire up and down the shunt wire until you find the spot where the shunt meter reads the same current as the calibrated meter. Remove power from the circuit and solder the second sense wire at that spot.

Conclusion. Using these methods you can make shunts for almost any range of DC currents. What's more, with a little care you should be able to make shunts accurate to within 5–10% if you keep them near room temperature. Of course, these shunts are not nearly as precise or temperature-stable as the commercial versions. Still, if you need one for a non-demanding application, or just want to have some fun, grab a few cents worth of wire and make your own shunt! Ω



WHAT'S NEW IN SOLAR POWER

"Building-Integrated Photovoltaic" Systems and the "Million Solar-Roof Initiative" are two reasons why your next home might be powered by the Sun.

BILL SIURU

Many homeowners have thought about going to solar power, but up to now might have been turned off by the hassles of a typical solar-panel array installation. Besides being quite costly, in most cases solar systems have been downright ugly. Indeed, some communities even have covenants against their use.

Fortunately, that is changing as photovoltaic suppliers, working with architects and builders, are developing "Building-Integrated Photovoltaic (BIPV)" systems. That has resulted in residential solar electric systems with greatly improved aesthetics—those BIPV systems are an integral part of the home design rather than an obvious and often unattractive add-on.

The new BIPV systems do double duty. They convert sunlight into electricity while performing the traditional jobs of roofing materials—protecting the structure from the elements while enhancing its appearance. Two examples of the new product are United Solar's Uni-Solar PV Shingles and Atlantis System's SunSlate Roofing System.

But there's more happening on the solar-energy front than just products that look much better. The cost of home photovoltaics has also come down, with even more reductions promised for the future. With ever improving technology, the cost of generating electricity using photovoltaics, now at 25 to 50 cents per kilowatt-hour, may go as low as 12 to 16 cents per kilowatt-hour. Looking at it in another way, photovoltaic modules that sold for $50 per rated watt of peak generating capacity in 1970 dollars, now sell for $5 to $7 per watt.

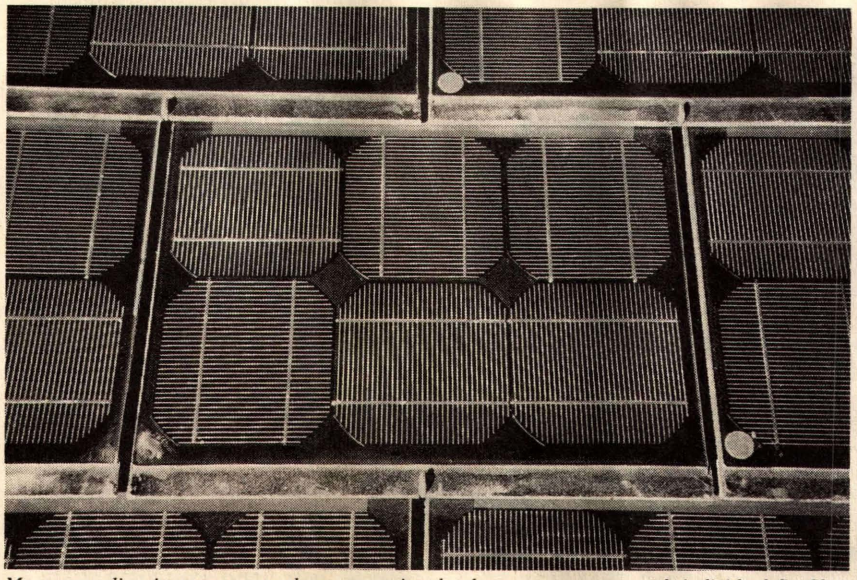
Solar Shingles. United Solar, a joint venture between Energy Conversion Devices, Inc. and Canon Inc., a leading international manufacturer of office equipment and photographic and optical products, is now offering a line of solar shingles for residential applications as well other innovative solar metal-roofing products for commercial buildings.

The flexible shingles use propriety thin-film semiconductor materials for the solar cells. Made of stainless steel coated with silicon semiconductor material and plastic, the solar shingles look like ordinary asphalt ones. The system integrates the solar shingle with the necessary "combiner" boxes, inverter, and wiring to convert sunlight into electric energy and distribute it directly to the building.

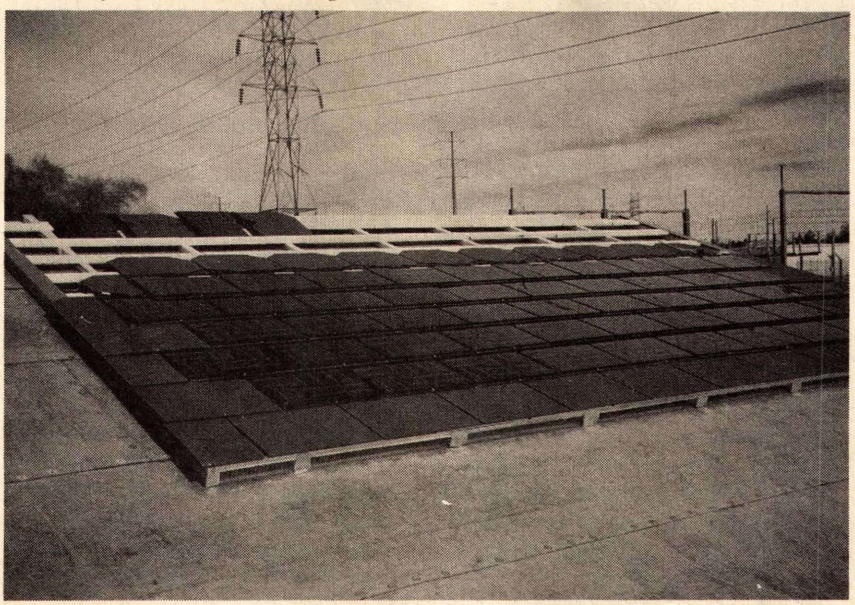
The Uni-Solar PV Shingles use amorphous silicon in thin films as the light-to-energy conversion material. While amorphous silicon has a lower conversion efficiency than the more traditional crystalline silicon, it potentially has a lower mass-production cost. Therefore, it is often seen as the best option for cost-effective home photovoltaic systems. What's more, recent advances have closed the gap between the two technologies. In particular, United Solar, under U.S. Department of Energy funding, has developed a thin-film amorphous-silicon cell that converts over 10% of sunlight into electricity, a significant improvement over the less than the 6% efficiency typical for this technology. That compares favorably to an efficiency of over 12% currently available from crystalline-silicon technology.

To achieve that efficiency, each cell in a Uni-Solar PV Shingle actually is made up of three separate p-i-n-type amorphous semiconductor solar sub-cells, each with a different spectral-response characteristic. That allows the cell to convert the different visible and near infrared wavelengths of sunlight with optimum efficiency.

United Solar and ECD have developed a low-cost manufacturing technique to make the thin-film amorphous-silicon alloy multi-junction solar modules. The pioneering technique uses one-half-mile-long substrates in a roll-to-roll process for manufacturing solar cells. The technique is similar to how newsprint



More appealing in appearance than conventional solar-power arrays, each individual SunSlate roofing tile, with a photovoltaic cell mounted on it, produces 12.5 watts. The tiles are nailed on to a structure just like conventional shingles



Part of a SunSlate-roofing-tile power array installed at the Arizona Public Service Company's STAR Center in Tempe, AZ. The complete system is rated at one kilowatt.

FOR MORE INFORMATION

United Solar Systems Inc.
1100 West Maple Road
Troy, MI 48084
Tel: 248-362-4170; Fax: 248-362-4942

Atlantis Systems, Inc.
233 S. Auburn, Suite 110
Colfax, CA 95713
Tel: 916-346-9595; Fax: 916-346-9795

and photographic film is produced. The production plant, which came on-line in March 1997, can manufacture enough solar panels to generate five-million watts of electrical energy annually.

The seven-foot-long Uni-Solar PV Shingles are installed just like regular shingles, and the job can be done by any roofer. The shingles are nailed onto the roof and the pair of wires attached to each shingle are inserted through holes in the wood decking. An electrician then connects the wires below the roof. A mixture of solar and ordinary shingles is used since, with sufficient sunlight, only one-third-of-a-roof's-worth of the shingles is needed to power the average home. The solar shingles blend in to the roofing pattern of the traditional asphalt shingles.

Uni-Solar PV Shingles have been installed on several demonstration homes. The Energy Efficient Home in Atlanta is fitted with a 2-kW solar-shingle array. Urban Options operates the Energy and Environmental Demonstration House in Lansing, MI, which features a 2-kW, 120 solar-shingle array. A 1.5-kW, 96-shingle system is installed at the University of Denver's astronomical observatory atop Mount Evans. That stand-alone system includes a DC-to-AC converter and 16 storage batteries that provide sufficient power to operate the lab's computers, instruments, and lights for up to five days. The Centex Home of the Future, built for the International Builder's Show in Dallas, uses an 800-watt, 200-square-foot Uni-Solar roof-shingle system that provides electricity for computers, security system, skylight-drive motor, garage-door opener, and two emergency service outlets. Operating independent of normal utility power, it provides both backup electricity during outages as well as saving on electrical-energy costs.

Atlantis Systems, Inc. is also offering aesthetically appealing BIPV capability with its SunSlate Roofing System. Each individual SunSlate roofing tile, with a photovoltaic cell mounted on it, produces 12.5 watts. The tiles are nailed on to a structure just like conventional shingles. The Sacramento Municipal Utility District (SMUD), along with Atlantis Systems, the Sacramento Housing and Redevelopment Agency, a local architectural firm, and a local construction company are installing SunSlate roofs on 20 new homes in a new 45-home subdivision in mid-town Sacramento. As part of SMUD's PV Pioneer II program, SMUD pays half of the costs of a new SunSlate system and is helping the new owner to obtain a reduced mortgage rate on the home. While the homeowner will be paying between $7,000 to $7,500 for a system, it will generate 75-85% of a home's electricity needs annually, meaning that the SunSlate system should pay for itself in about 12 years.

Recently ETA Engineering in Scottsdale, AZ installed an 80-SunSlate-roofing-tile array for Arizona Public Service Company at its STAR Center in Tempe, AZ. The total system

(Continued on page 62)

Alternate Power Sources for Cars, One-Chip Line-Powered Supplies, and More.

LET'S START THIS MONTH WITH A QUICK QUESTION: WHICH IS MORE EFFICIENT—A HEAT ENGINE OR A FUEL CELL? BEFORE YOU ANSWER, NOTE THAT THE FOLKS AT *POWER ENGINEERING* MAGAZINE REPORT THAT THE LATEST POWER PLANTS are approaching a stunning 60% thermal efficiency by using close-coupled multi-cycling. Also note that one power utility is extremely proud of its real world 50% electrical-efficiency fuel-cell installations.

As always, there will be intelligent choices and reasonable tradeoffs. And, as always, a good starting point should be accurate technical information from unbiased sources. Let's see where this leads us as we seek out some . . .

Transportation Alternatives

A personal-transportation vehicle consists largely of an energy carrier and an energy converter. Three valid measurements of the energy carrier are: "How heavy is it?" "How much room does it take up?" And "What is the total cost per mile?" Gasoline is your baseline energy carrier at 9000 watt-hours per liter and 13,500 watt-hours per kilogram. With a cost of roughly seven cents per mile for the consumables and 30 cents per mile for payments, taxes, and insurance.

These figures define the capability of the carrier itself. Such figures have to be adjusted downward when you factor in how efficiently your energy can be used and how much structure, containment, or whatever is needed to safely hold the carrier.

Naturally, any proposed alternates also must be adjusted downward as well. Figures must also be modified for the distortions caused by taxes or any hidden subsidies.

Because of thermodynamic laws, an ICE (Internal Combustion Engine) has to throw away a lot of heat in order to produce a little mechanical power. The best you can even hope to do is called the Carnot efficiency limit and is determined solely by the high-side and low-side temperatures. The typical automobile ICE-efficiency at the flywheel is around 30 percent.

The claims of "how much better" the alternatives might be are often outrageously overstated. For instance, a typical electric motor of suitable size and price probably provides an efficiency of no better than 90 percent. Its controller will be hard pressed to hit 85, and its wiring will be unable to exceed 98. Combine these for a realistic 75 percent efficiency. And, no, regenerative braking does not help nearly as much as some of its more-vocal proponents claim.

What if you add a fuel cell to the mix? It turns out that the best of hydrogen-electrolysis cells are one-sixth endothermic, so you'd pretty much expect the best fuel cell to end up as one-sixth exothermic, which means that 83 percent efficiency is the best you are likely to do. Combine fuel cells with electric motors, and you are down at a 63-percent efficiency limit. That's certainly better than gasoline engines, but not spectacularly so.

Here's how I see some of the key issues that seem to involve personal transportation alternatives:

Business as usual: A lot can still be done to tweak the performance of conventional ICEs. Examples include ceramic cylinders, six-cycle operation, ultra-lean combustion, modest hydrogen injection, valve timing done on-the-fly, improved turbocharging, adjustable compression, and possibly even a new bottoming cycle. A company by the name of Aurora Engineering has some exceptionally innovative new stuff in this area, including things like electrically actuated valves and combination starter-alternator-flywheel packages that even can double as AC power generators.

Turbines: Turbines provide high power in a small and lightweight package. They are superb for airplanes, but are grossly inefficient at less than full output and usually run only at extreme speeds. I'd expect this one to literally stay off the ground.

Liquefied natural gas: The energy

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Life With an Electric Car, N. Perrin
Near Term Electric Vehicle Costs, J. Sawin
The New Electric Vehicles, M. Hackleman
Solo: Life With an Electric Car, N. Perrin
The Lost Chord: The Story Tellers History of the Electric Car, B. Taylor
Taking Charge - The Electric Automobile in America, B. Schiffer

FIG. 1—SOME CURRENT BOOKS on hybrid and electric vehicles. More title information can be found at http://www.tinaja.com/amlink01.html.

density here is certainly useful, but still remains significantly less than gasoline. The same goes for propane. The popularity of this method waxes and wanes with the relative economics of oil versus gas, and it gets distorted by taxes, subsidies, and hidden agendas. Infrastructure is obviously limited. I don't see this option getting very far unless economics radically change.

Grain alcohol: When based upon an American-farm corn economy, a lot more energy will go into producing alcohol than you can ever hope to get back. From an energy standpoint, the process can be considered a giant funnel. You pour gasoline in the top and alcohol dribbles out the bottom. Further, alcohol additives appear to be causing far more problems than they solve. Yes, there is definitely a third-world subsistence potential by using bagasse (sugar cane residue) or similar feedstocks. Otherwise, this one makes no engineering sense whatsoever. At least not to me.

Steam engines: Believe it or not, the steam-powered automobile was done in by hoof-and-mouth disease. Seems they drained all those public horse troughs just as inferior gas engines were starting to discover production economics. A steam engine is vastly simpler, offers high power on every stroke, and needs neither a clutch nor a transmission. Key issues remain closed-cycle vapor re-condensation, corrosion or scaling problems, and any inefficient superheating techniques. This one still has lots of potential, but seems to lack a credible champion.

Pure electrics: The energy density of batteries is utterly abysmal when compared to gasoline—only 35 watt-hours per kilogram for lead-acid and ten times that for lithium. The range, weight, and charging infrastructure remain key problems. It also turns out that any battery

operates by knocking loose one single electron in its outer shell. So, the smaller the atom, the better the energy density. I see nothing ever beating out lithium (atomic number=3) for the ultimate energy density. A useful Web site on this topic can be found at www.evworld.com.

Because laptop computers are an instant and a billion-dollar market for improved battery technology, I'd expect the computer folks to inadvertently "solve" the electric-car problem, in spades. They clearly have the money and the motivation.

Fuel cells: The essential difference between a battery and a fuel cell is that the fuel cell continually receives external chemical energy from one or more product streams, often by using hydrogen and oxygen. The crucial advantage of a fuel cell is that it is not a heat engine and thus will not be Carnot limited at its best efficiency. Another major advantage is that its main waste product is water.

Central issues in fuel cells today involve the reforming of methane or gasoline to make useful feedstocks, and trying to get the efficiency and performance up and the costs down. Fuel cells are still not very efficient, nor all that great at any suddenly changing power levels. Ballard is one high-profile source. A leading Web site on this topic is www.fuelcells.org. A major technical publication is the *Hydrogen and Fuel Cell Letter*.

Hybrids: Any ICE run at a constant speed is easily optimized. Batteries aren't all that heavy if you don't use that many of them. In a serial hybrid, the engine drives a generator, which powers the motors, eliminating the drive train. In a parallel hybrid, both engine and electric motors can drive the wheels, and both can be one half of the needed peak power. I believe this one is by far the best near-term solution. Amory Lovins of the Rocky Mountain Institute is one champion of hybrid vehicles. Be sure to visit his site at www.rmi.org.

Hydrogen: The energy density by weight of hydrogen is outstanding—three times gasoline at 39,000 watt-hours per kilogram. Hydrogen routed to either an ICE or a fuel cell produces primarily water vapor as waste. Sadly, the energy density by volume as a gas is a pitifully absurd 3.5 watt-hours per STP liter. Even when liquefied, there is around four times less hydrogen in a gallon of liquid hydrogen than there is in a gallon of gasoline.

Alternative Automotive Resources

AEE Energy Books
PO Box 1026
Lilburn, GA 30226
(404) 925-9558

Aurora Engineering
4823 S Marine Avenue
Lawndale, CA 90260
(310) 675-0804

Automotive Industries
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Radnor, PA 19080
(215) 964-4876

Ballard Power Systems
9000 Glenlyon Pkwy.
Burnaby, BC V5J 5J9
Canada
(604) 412-3123

Battery & EV Technology
25 Van Zant St. Suite 13
Norwalk, CT 06855
(203) 853-4266

Robert Bentley
1033 Massachusetts Ave.
Cambridge, MA 02138
(617) 547-4170

Chilton Publications
825 7th Ave.
New York, NY 10019
(212) 887-8400

EPRI Journal
PO Box 10412
Palo Alto, CA 94303
(415) 855-2000

EV World
Box 461132
Papillion, NE 68046
(402) 339-9877

Home Power
PO Box 520
Ashland, OR 97520
(800) 707-6585

Human Power Vehicle Association
PO Box 51255
Indianapolis, IN 46251
(317) 876-9478

Hydrogen & Fuel Cell Letter
Grinnell St.
PO Box 14
Rhinecliff, NY 12574
(914) 876-5988

ITS World
859 Willamette St.
Eugene OR 97401
(541) 343-1200

National Renewable Energy Lab
1617 Cole Blvd.
Golden, CO 80401
(303) 231-7681

Power Engineering
1421 S Sheridan Rd.
Tulsa, OK 74112
(918) 835-3161

Powerball Industries
2095 W 2200 St.
West Valley City, UT 84119
(801) 974-9120

Railbike Newsletter
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Coeur d'Alene, ID 83814
(208) 765-2831

Rocky Mountain Institute
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Snowmass, CO 81654
(970) 927-3851

SAE
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Warrendale, PA 15096
(412) 776-4841

Whole Earth Review
PO Box 38
Sausalito, CA 94966
(415) 332-1716

The "make it or break it" issue of a hydrogen economy involves finding ways to safely store hydrogen in a dense form. A graphite nanotube storage scheme pioneered by Nelly Rodriguez offers eight times the density of gasoline, but this technology seems slow in coming out of the lab, mostly due to lifetime and reuse considerations. More on hydrogen advantages and disadvantages can be found in MUSE112.PDF on my www.tinaja.com Web site. Hydrogen safety is discussed at www-osma.lerc.nasa.gov/Ism.

Powerballs: These are simply spheres full of sodium—cracking the sphere underwater generates hydrogen. The densities involved are about the same as liquid hydrogen. All hydrocarbon pollution is eliminated by not using carbon, but to me, it seems that a lot of safety, hazmat, and recycling issues have not yet been realistically addressed. So far, this option seems to be a one-man show at Powerball Industries in Utah. More powerball details are found at www.powerball.net/index.html.

A variation on powerballs sparks aluminum under water to generate hydro-

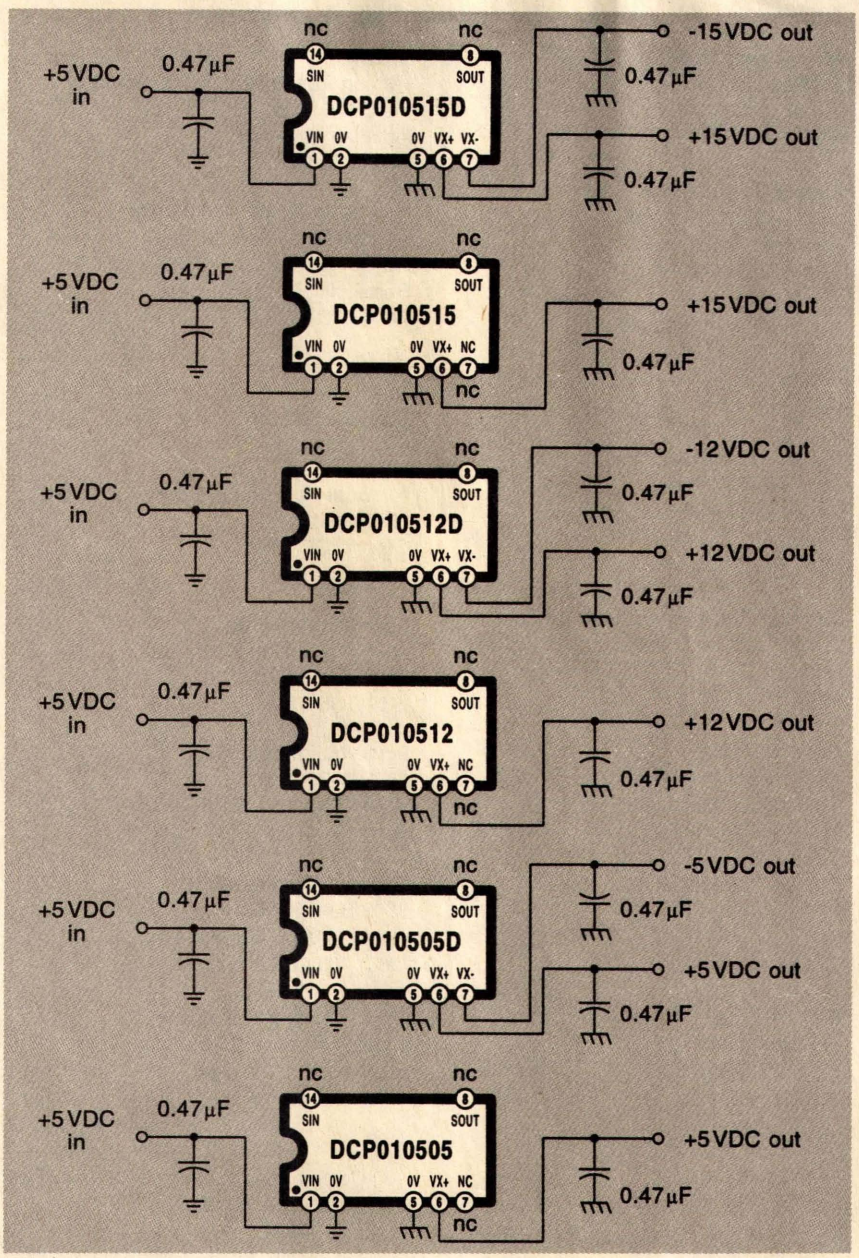

FIG. 2—A NEW LINE OF ISOLATED POWER SUPPLY hybrid devices from Burr-Brown offers 50 mils output, 1000-volt isolation and a $6 cost in a 14-pin minidip. As shown here, a variety of single and dual output devices is available.

gen, similar to an EDM spark machine. This technology appears to be mostly urban lore pseudoscience and obviously fails to deliver. If you have your electricity already onboard, you are clearly much better off routing it directly to your wheel motors. The sapphire-hard aluminum oxide waste product is highly abrasive and quite fouling as well.

Flywheels: Ordinary flywheels offer about the same energy density as lead acid batteries, while premium ones pretty much approach lithium. Safety and gyroscopic problems have been solved. A crucial limitation is windup time. If you are trying to "charge" your flywheel ten times faster than you use it, then you need ten times the drive motor. My feelings on this one is "maybe for buses".

Nitrogen power: This scheme is just plain cute. Take a tank full of liquid nitrogen and expand the gas into an ordinary heat-sunk cylinder, using ambient as the hot side of your ultra-simple heat engine. As with steam power, there's no need for a clutch or transmission. Stock air motors work just fine. You get decent efficiencies and lead-acid performance at one twentieth the cost. Summer air conditioning is also trivial.

Nitrogen power seems a student-project favorite. Several nitrogen car links appear on my Web site.

Thermoelectric recovery: Some older Peltier and related thermoelectric devices have been proposed to try and recover energy from exhaust or muffler heat. The devices to date are so inefficient that they never can even hope to return their cost, let alone accomplish anything useful. Usually a minor tire-pressure adjustment can deliver more energy savings for you.

A somewhat random assortment of my favorite alternative automotive resources is shown as this month's resource sidebar. Additional information on some of these topics is also found at www.tinaja.com/h2gas01.html

I have added access to most of the more accessible books on electric-vehicle subjects to my Web site at www.tinja.com/amlink01.html. A summary listing appears in Fig. 1. Again, I feel that hybrids blow away electrics on all counts, and will continue to do so until fundamental battery energy-density problems are economically resolved.

An Isolated Power Supply

The Burr-Brown folks have just introduced a new series of isolated hybrid power supplies. All these $6 devices are the size and shape of a 14-pin minidip, give output currents to fifty mils, and can provide safety isolation to 1000 volts.

Inside the hybrid is a 400-kHz oscillator, a tiny toroidal transformer, and some output diodes. Only two external capacitors are needed to get these to work. Obvious uses include AC-line isolation, eliminating hum and ground loops, doing high-side current sensing, and communication-line isolation.

These also let you do such tricks as very-low-frequency on-off data translation or letting both sides of a bridge rectifier tie to ground. The devices track the input voltage and offer only ten percent regulation, so some low-dropout post regulator might also be needed.

As shown in Fig. 2, various models of the device offer single and dual outputs. You can also conjure up your own custom isolated power converters through use of the individual bits and pieces separately sold as Burr-Brown's PWS745 and PWS750 products.

Another Approach

There is an obviously need for a device that to date is not available: A 79-

cent chip that starts off with a raw 110-volt AC input and then cheaply outputs isolated and hassle-free +5 volts at an amp or whatever.

There is one new device that comes close: the Harris HV2405E. That device does accept AC-line voltage as its input, but does not include the essential safety isolation. The high power (2 watts) dissipated in the input resistor also severely limits the efficiency and package size.

Even so, the device works equally well at 110 and 220 volts without any jumpers or switching. If you'd like to experiment with it, a circuit that provides a fixed 5-volt output is shown in Fig. 3, while an adjustable 5- to 20-volt version is shown in Fig. 4.

Again, be aware that the lack of isolation means that **a severe shock hazard could potentially exist**, so be extra sure to take the usual safety precautions. If you are at all unsure of what that means, or are inexperienced in working with AC circuits, maybe it would be better if you just left this one alone.

NAMES AND NUMBERS

Alfa Aesar
30 Bond Street
Ward Hill, MA 01835
(800) 343-0660

Appliance Manufacturer
29100 Aurora Rd #200
Solon, OH 44139
(216) 349-3060

Burr-Brown
6730 S Tucson Blvd.
Tucson, AZ 85706
(520) 746-1111

CastCraft
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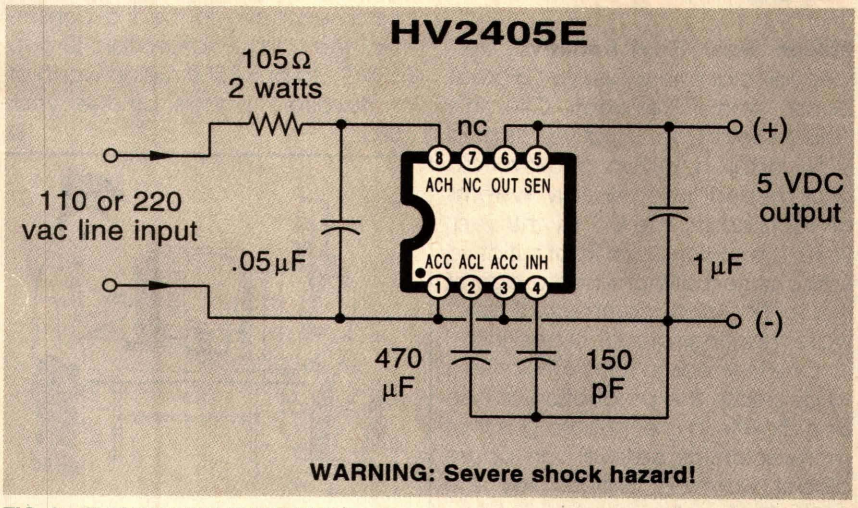


FIG. 3—THIS AC-LINE OPERATED 5-volt power supply uses a new Harris chip. Note that safety isolation is NOT provided so the potential for a severe shock hazard exists.

New Tech Lit

From Texas Instruments, comes a new two-volume amplifier-chip databook library. From Harris, there's a nice booklet about *Semiconductor Solutions for Multimedia, Video, and Imaging*.

From That Corporation, comes a new $3 rms level-detector IC that provides wide bandwidth, a log output, and crest factors as high as eight. It is intended for electronic music apps.

New from NTE is a fat semiconductor directory that cross-references over 260,000 chips of one sort or another. From Aesar comes a free periodic table of the elements wall poster.

Certain new low temperature alloys that melt at 158 degrees Fahrenheit are offered by MCP Systems. Their intended use is for low-cost prototyping and mold-making intermediates. Useful casting plastics and mold-making materials are sold by Polytek, who has a free *Developments* newsletter. Another source is CastCraft.

A wide variety of educational and other laser products are stocked by Kentek. Ask for catalog #118.

A new magneto-coloric magnetic refrigeration material is described in *Science* for March 27, 1998 on page 2045. That material is six times more effective than the previous ones and operates at room temperature. Thus, only one sixth of the newer material is needed for a home refrigerator or similar heat-transfer system.

For those unfamiliar with how this works, basically any magnetic material absorbs heat energy whenever it is magnetized and releases heat energy when raised above its Curie Point, the temperature where it totally loses its magnetic properties. While not quite solid-state (your material has to slowly move from

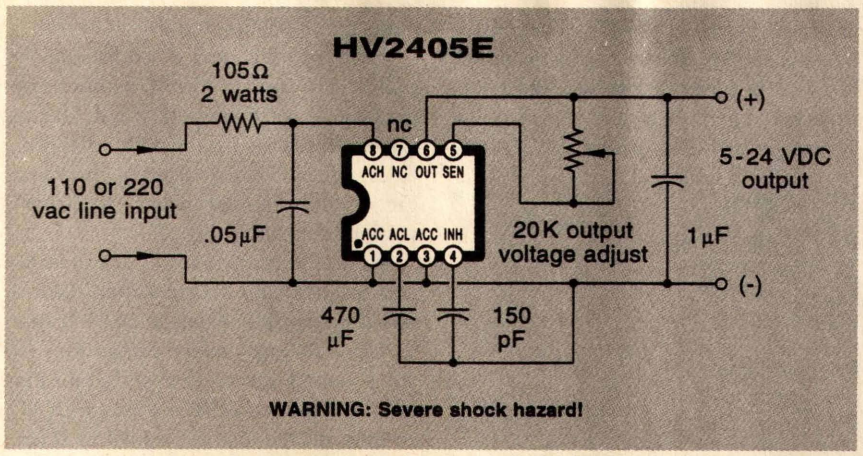


FIG. 4—ADDING A POTENTIOMETER to the basic circuit in Fig. 3 yields an adjustable supply with a 5- to 24-volt output range.

source to sink and back again), the mechanics involved are simpler than a compressor, and no freon or other fluids are involved. Additional magnetic-refrigeration coverage appears in the March 1998 issue of *Appliance Manufacturer* on page 14. More details on magnetic refrigeration can also be found in HACK33.PDF and RESBN63.PDF on my Web site, and in volume III of my "Hardware Hacker" reprints.

Walt Pyle has released his new *Hydrogen Solar Chronicles* book, a useful hands-on compendium of his collected reprints from *Home Power* magazine. More information on his book is at www.tinaja.com/h2gas01.html.

Time Compression Technologies is a new trade journal on Santa Claus machines, rapid prototyping systems, CAD/CAM, and industrial design. A lot more on the Santa Claus machines themselves and lots of links are at www.tinaja.com/santa01.html.

Our second trade journal for this month is the new *Integrated Design & Manufacturing*.

Some nice reprints on wavelets are newly offered by the folks at MatLab. Additional resources and links are at www.tinaja.com/wave01.html.

Some great bargains in Tektronix 2213 oscilloscopes newly appear at www.tinaja.com/barg01.html.

Bunches of freebie tutorials about wireless and communications topics appear at www.iec.org.

For all the fundamentals of active filters in an easy-to-understand and easier-to-use format, check out my *Active Filter Cookbook*. Ordering details are found in my nearby Synergetics ad, or pick up your catalog instantly online at my www.tinaja.com/synlib01.html.

Magic Sinewaves are a brand new opportunity that lets you generate surprisingly efficient and elegantly simple high-power waveforms for use in industrial, automotive, solar, and home-energy efficiency areas. I've recently posted a lot of new files to www.tinaja.com/magsn01.html.

Our usual reminders that most of the mentioned resources appear in the Names and Numbers or Alternative Automotive Resources sidebars, that we offer a free US helpline per the nearby box, and that my Guru's Lair Web site is www.tinaja.com. EN

SOLAR POWER

(continued from page 54)

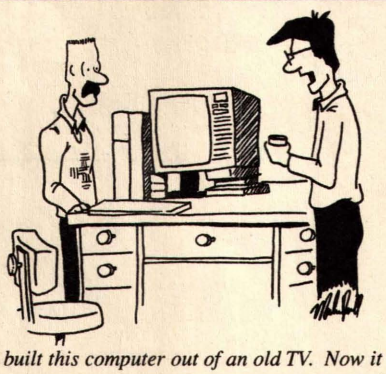
is rated at one kilowatt. Like Uni-Solar PV Shingles, only a small portion of the roof needs to be covered with the photovoltaic tiles to provide sufficient electricity.

Million Solar Roof Initiative. Residential solar energy will get a great boost from President Clinton's "Million Solar Roof Initiative." Its goal is to install a million photovoltaic and thermal solar energy systems on roofs across the U.S. by the year 2010. The Million Solar Roof Initiative is also aimed at increased usage of residential and commercial solar water heating solar pool heating.

One key reason for the initiative is to decrease the production of carbon dioxide, a greenhouse gas that many scientists believe can cause global warming. Experts say the amount of carbon dioxide not produced by a million solar roofs would be like getting 850,000 cars off the road. These million solar roofs could also reduce energy consumption, pollution, and the country's reliance on foreign petroleum. Further, by the year 2010, about 70,000 new high-technology jobs could be created to meet the new demand for photovoltaic, solar water heating, and related technologies. The initiative will bring solar power not only to private homes, but also to schools, libraries, and large and small businesses. Finally, as economies of scale kick in as a result of increased usage and mass production, the initiative is seen as a way to reduce the cost of solar-energy products.

The Million Solar Roof Initiative is being led by the U.S. Department of Energy and involves the building industry, local governments, state agencies, the solar industry, electric utilities, and non-governmental organizations. The federal government is taking the lead by accelerating its use of solar energy. It is important to note that the government alone owns nearly a half-million buildings and spends $3 billion annually for electricity, making it the world's largest single user of energy. Add to that the more than 76-million residential buildings and almost five-million commercial buildings, plus an additional 38 million projected by the year 2010 in the U.S. alone, and it is easy to see that the potential for solar roofs is tremendous.

Because of this potential, electric utilities are already getting in on the action. For example, some 68 utilities serving 40% of U.S. electrical customers have formed a consortium, the Utility Photovoltaic Group (UPVG), to buy $500 million worth of photovoltaic panels by the year 2003. Ω



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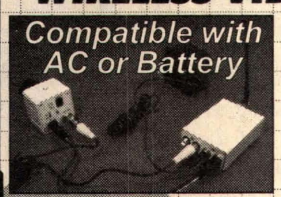

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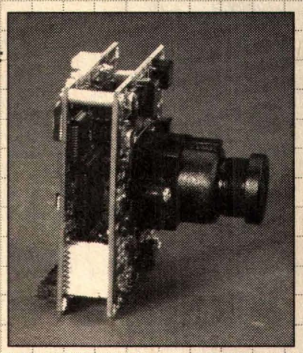

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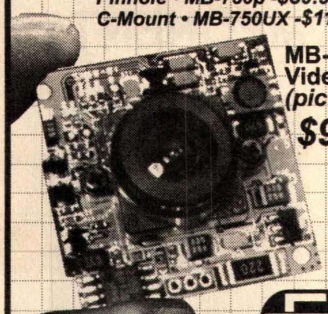

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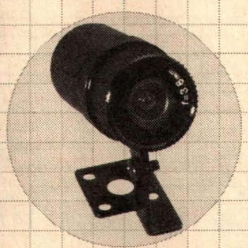

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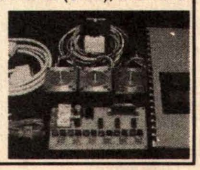

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Continuity Beeper/Diode	•	•	•	•	•	•	•	•
Temperature w/Probe, Type K			•					
TRhFE				•	•		•	
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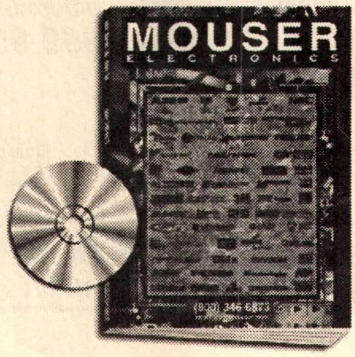

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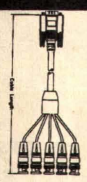

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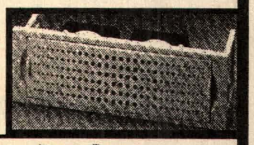

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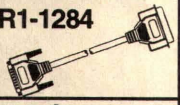

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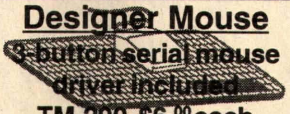

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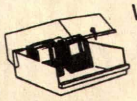

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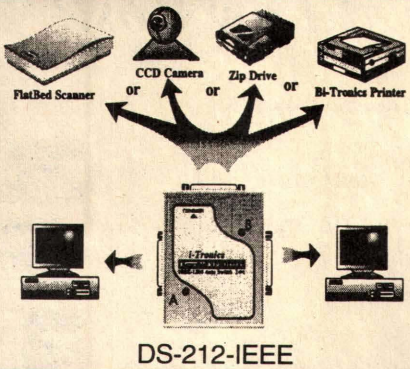

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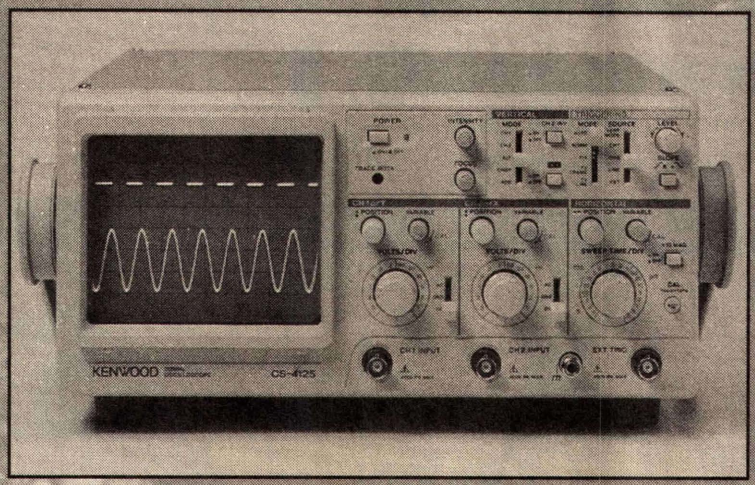

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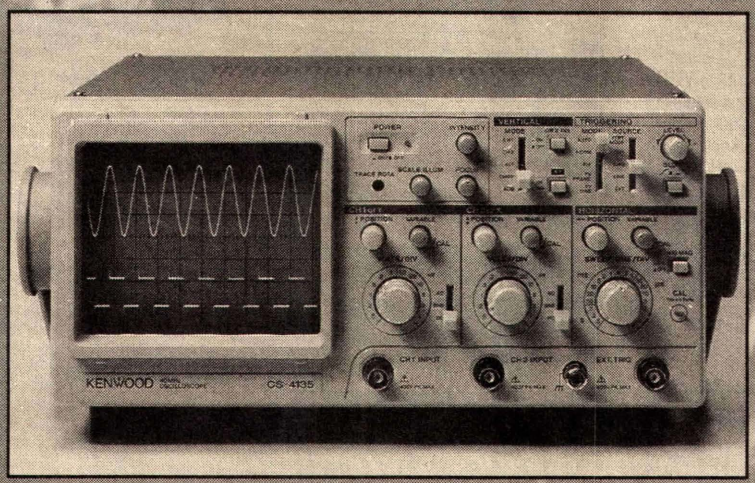

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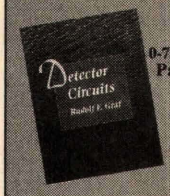

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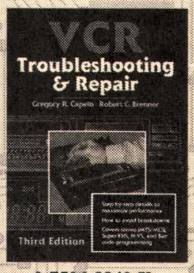

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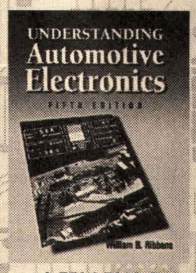

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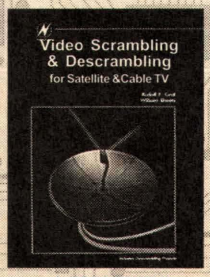

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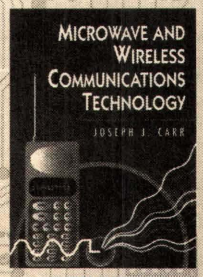

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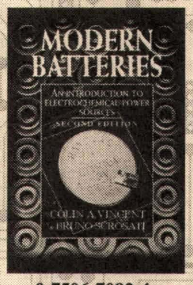

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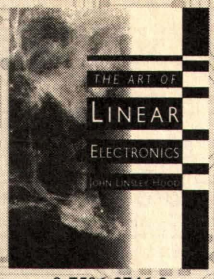

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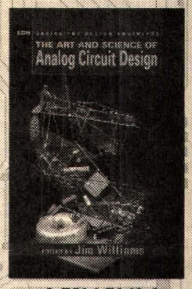

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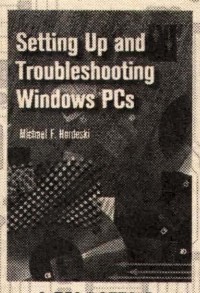

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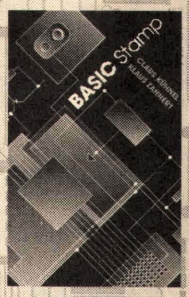

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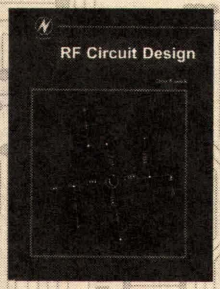

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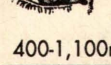

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Clearance Sale — FM Wireless Microphone TY-35

This is a low power real FM transmitter. Transmit frequency within 88-108 MHz. Transmit range about 200 ft. It has high sensitivity sound pickup by a capacitance microphone. May be used strictly for series purposes such as remote wireless monitering.

Kit ~~$ 12.50~~ **6.99**

4½ Digital LED Panel Meter SM-48

Clearance Sale

This precision digital meter is a stand-alone voltmeter-ammeter or can interface with a computer! 4½ digit 0.55" LED display. Temperature compensated to 100 PPM/°C. Operating temperature range is 0°C to +70°C. Outputs include BCD date, Busy and strobe. Panel reading can be latched on hold.

Kit ~~$ 39.00~~ **20.00**

Stereo Loudspeaker Protector TY-25 ▲

Super fast acting relay protects speakers against destructive DC voltages. Can connect directly to a power amplifier or can use a separate power supply. Has a 3 second turn-on delay to avoid turn-on thumps.

Kit: $ 16.75

Regulated DC Power Supply TR-503 ▲▲

It is short circuit proof & has overload protection. Output voltage is variable over a range of 0-50 volts. Current limit trip is adjustable up to max of 3A. May use Mark V #002 transformer.

Kit: $ 18.75

Fluorescent Light Driver TY-2 ▲ (1 lb.)

This unit drives 6-40 watts fluorescent light for portable and emergency use. Works from a 7.2 - 16 VDC battery. Includes a "Hi-Efficiency Switching Mode IC Driving Circuit" suitable for use with different lights.

Kit:$ ~~14.75~~ **9.99**

120-250W Mosfet Power Mono Amplifier AF-2 (6 lbs.) ▲▲

Power Output: 250W into 4 ohms RMS(42VX2 6A transformer is used). 120W into 4 ohms RMS(33VX2 4A transformer is used). Frequency Response: 3Hz-22,000Hz. THD: <0.03%. Signal to Noise Ratio: 91dB. Sensitivity: 1V RMS at 47k. Load Impedance: 4 or 8 ohms. Power Requirement: ±46VDC 4A or ±60VDC 6A. May use Mark V model 012 Transformer. Suggested Capacitor 8,200uf 100V Model 020. Suggested Metal Cabinet LG-1925.

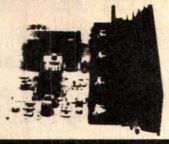
Kit: $ ~~89.80~~ **76.33** Asmb.$ 114.80

500-in-one Electronic Lab Kit

KA-904 $129.99

Contains its own computer with a simple explanation of the basic(Assembler) language required for operation. Compile programs to discover how computers operate while gaining an understanding of hardware & software. With easy-to-follow manual which explains by comprehensive diagrams. Requires 4 "AA" batteries.

300W High Power Mono Amplifier TA-3600 (5 lbs.) ▲▲▲



Power Output: 300W into 8 ohms RMS. 540W music power into 8 ohms. Frequency Response: 10Hz-20KHz. THD: < 0.05%. Sensitivity: 1V RMS at 47K. Power Requirement: 60 to 75 VDC at 8A. May use Mark V Model 007 or 009 Transformer. Suggested Capacitor: 8,200uf 100V Model 020 Capacitor. Suggested Metal Cabinet LG-1925.

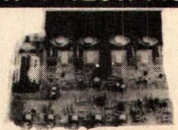
75.65
Kit:$ ~~89.00~~
Asmb.$ 115.00

150MHz 8 Digit Frequency Counter SM-100 (2 lbs.)

It is used for adjustment, test & repair of any kind of high frequency circuit products. It can give up to 8 digit of resolution for a wide frequency range 10Hz - 150 MHz. The last input frequency can HOLD on the display for future reference & comparison. The circuit structure is compact & reliable for the most updated A/D LSI circuitry. The input impedance is 1M ohm. ▲▲▲

Kit:$ ~~79.00~~ **68.00**
Asmb.$ 99.00

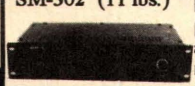
120W + 120W Pre & Main Stereo Amplifier TA-800MK2 (4 lbs.) ▲▲



Power Output: 120W into 4 ohms RMS. 72W into 8 ohms RMS. Frequency Response: 10 - 20 KHZ. THD: < 0.01%. Tone Control: Bass ±12dB, Mid ±8dB, Treble ±8dB. Sensitivity: Phono Input, 3mV into 47K. Line, 0.3V into 47K. Signal to Noise Ratio: 86dB. Power Requirement: 40V DC @ 6A. May use Mark V Model 001 or 008 Transformer. Suggested Metal Cabinet Model LG-1924.

Kit: $ ~~67.92~~ **61.13** Asmb.$ 86.95

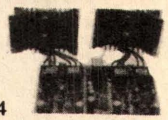
60 + 60W Stereo Power Amp. SM-302 (11 lbs.) ▲▲



It provides 3 input jack pairs. One pair accept a high impedance micro-phone. The two remaining pairs are for high & low level input sources. Power Output: 60W per channel into 4 ohms RMS. 20Hz-20KHz. THD:<0.1%. Input Sensitivity :Mic /Guitar 10mV, Hi 380mV, Lo 640mV.Ready to plug in when assembled.

Kit:$ ~~85.00~~ **76.50**

80W + 80W Pure DC Stereo Main Power Amplifier TA-802 (4 lbs.) ▲▲



Power Output: 80W per channel into 8 ohms. THD: < 0.05%. Frequency Response: DC to 200 KHZ, -0 dB, -3dB @ 1W. Power Requirement: 30V AC X 2 @ 6A. May use Mark V Model 001 or 008 Transformer. Suggested Capacitor 8,200uf 50V Model 017. Suggested Metal Cabinet LG-1924

42.45
Kit: $ ~~49.94~~
Asmb.$ 69.94

30W + 30W Pre & Main Stereo Amplifier TA-323A (1 lb.) ▲

Power Output: 30W into 8 ohms RMS per channel. THD: < 0.1% from 100 HZ to 10 KHZ. Sensitivity: Phono 3mV @ 47K. Tuner, Tape 130mV @47K. Signal to Noise ratio: 80dB. Power Requirement: 22 to 36V AC, 3A. May use Mark V Model 002 Transformer. Suggested Cabinet LG-1684.

29.25
Kit: $ ~~32.50~~ Asmb.$ 50.50

300-in-one Electronic Lab Kit ▲▲

Learn about transistors, capacitors & electronic circuits. Build electronic games, battery checker & more. It even includes a breadboard for adding your own components. Complete with easy-to-follow manuel. Requires 6 "AA" batteries. (6 lbs.)

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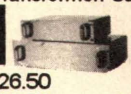
Metal Cabinets Aluminum Front Panel



LG-1273	3x12x7" (4 lbs.)	$ 26.50
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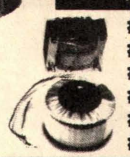

# 001	28V/30V x2	6A	$ 30.00
# 002	36V x2	3A	25.00
# 003	40V x2	6A	32.00
# 008**	28V/30V x2	6A	42.00
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# 012**	33/40/42V x2	6A	52.00

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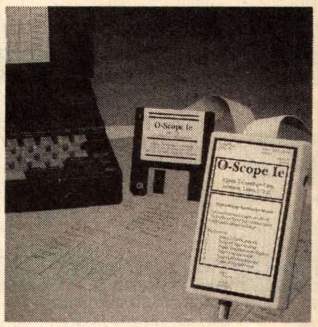

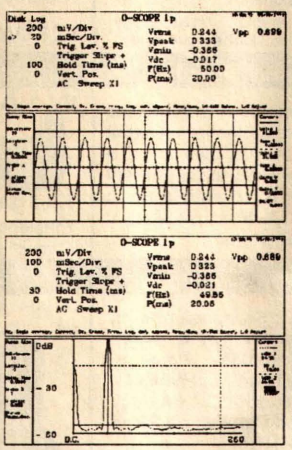

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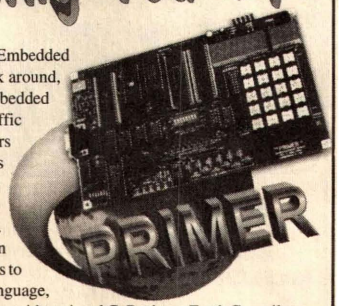

Are you interested in Microprocessors & Embedded Control Systems? If not you should be! Look around, just about everything these days has an embedded microprocessor in it. TVs, cars, radios, traffic lights & even toys have embedded computers controlling their actions. The Primer Trainer is the tool that can not only teach you how these devices operate but give you the opportunity to program these types of systems yourself. Examples & exercises in the Self Instruction manual take you from writing simple programs to controlling motors. Start out in Machine language, then move on to Assembler, & then continue on with optional C, Basic, or Forth Compilers. So don't be left behind; this is information you need to know!

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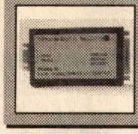
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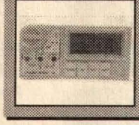
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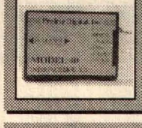
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CIRCLE 215 ON FREE INFORMATION CARD

NEW LITERATURE

continued from page 34

tems, as well as well as optical tools and vacuums. Accessories and items for computers, networks, and telecommunications are also included. Hewlett-Packard products are covered in a separate section.

Each item is accompanied by a full-color photo. A complete index is found at the back of the catalog.

Net Guide: Your Complete Guide to the Internet and Online Services

by Michael Wolff
Dell Publishing
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New York, NY 10036
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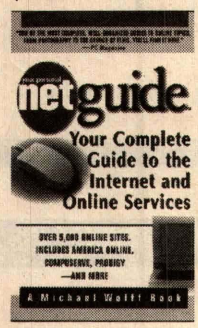

CIRCLE 341 ON FREE INFORMATION CARD

In March 1996, a Nielsen survey found that 56 million people in the U.S. and Canada have access to the Internet. At this growth rate, over 50% of the U.S. population will be Internet users by the year 2000. With as many as 50,000 new Web sites beginning each day, Net-users will welcome this moderately priced, easy-to-use resource guide to Internet services and sites.

It is a comprehensive volume divided into helpful sections that provide simple, practical advice about surfing the Net: from choosing a modem to finding the right online service to locating obscure sites. Subject areas include Entertainment (movies, TV, music), Sci-Fi, Fun & Games (comics, cartoons, video games), Home & Health, The Digital World, Virtual Newsstand, Politics & Government, and Dollars & Sense (personal finance and taxes).

Over 5000 online sites are included. In addition to other subject areas, hundreds of Internet addresses for current information on topics ranging from TV shows to literature are provided.

This book is the first in Dell's series of Internet guidebooks: *NetSci-Fi*, *NetStudy*, *NetSports*, *NetMoney*, and *NetDoctor*. All of them are shorter guides to the best sites to visit in their particular interest area, and they all include commentary and site reviews.

Tools, Test Equipment and Supplies—1998 Edition

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CIRCLE 342 ON FREE INFORMATION CARD

Designed for engineers, managers, technicians, and hobbyists, this catalog is filled with hundreds of new test instruments and tools. Featured are quality products from brand-name manufacturers for testing, repairing, and assembling electronic equipment. New product highlights include Fluke's redesigned 70 "Series III" DMMs; Tektronix' TDS "600 Series" digital real-time oscilloscopes; and Metcal rework stations. Complete specifications are given for each product.

There is a full selection of DMMs, portable and bench-top digital storage scopes, custom tool kits, power supplies, EPROM programmers, soldering and desoldering equipment, and breadboards. In addition, heat guns, measuring tools, adhesives, and precision hand tools are covered, as well as reference books. Also included are the popular lines of communication test equipment, ESD-protection products, ozone safe cleaners, magnifiers, inspection equipment, workbenches, tool cases, and more.

Oracle8, The Complete Reference

by George Koch and Kevin Loney
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Fax: 510-549-6603
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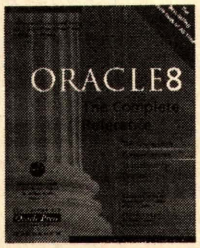

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This expanded reference guide gives in-depth coverage of object technology. It is the single most comprehensive sourcebook/CD-ROM package available for Oracle Server. Giving complete, encyclopedic coverage of Oracle Server software releases 7 through 8, this volume will be invaluable for database administrators, developers, programmers, and high-end users.

Divided into six logical parts, this special hard-cover edition contains over 200 pages of new material. Quick, easy-to-follow references to critical database concepts and new features of the program provide a handy guide to readers.

This edition covers new material on implementing object technology in Oracle8, an introduction to database concepts, detailed information on how to develop applications with Oracle Context, and a complete presentation of SQL, including a new chapter on operations for beginning users. Other material includes "A Hitchhiker's Guide to the Oracle Data Dictionary," an alphabetical command reference that lists the syntax and sample usage for each command, and an easy-to-reference list of the downloadable tables used in the book.

The included companion CD-ROM for Windows 3.1 and Windows 95 offers a fully searchable electronic version of the book, which will give readers quick and convenient access to all its information. The CD contains all of the tables, code, and examples from the book, which were previously sold separately. EN

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We cannot bill for classified ads. **PAYMENT IN FULL MUST ACCOMPANY YOUR ORDER.** We do permit repeat ads or multiple ads in the same issue, but in all cases, full payment must accompany your order.

WHAT WE DO

The first word and company name of each ad are set in bold caps at no extra charge. No special positioning, centering, dots, extra space, etc. can be accommodated.

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Our classified ad rate is $2.50 per word. Minimum charge is $37.50 per ad per insertion (15 words). Any words that you want set in bold are each .40 extra. Indicate bold words by underlining. Words normally written in all caps and accepted abbreviations are not charged anything additional. State abbreviations must be post office 2-letter abbreviations. A phone number is one word.

If you use a Box number you must include your permanent address and phone number for our files. ADS SUBMITTED WITHOUT THIS INFORMATION WILL NOT BE ACCEPTED.

For firms or individuals offering Commercial products or Services. **Minimum 15 Words.** 5% discount for same ad in 6 issues within one year; 10% discount for same ad in 12 issues.**Boldface (not available as all caps),** add .40 per word additional. **Entire ad in boldface,** add 20%. **Tint screen behind entire ad,** add 25%. **Tint screen plus all boldface ad,** add 45%. **Expanded type ad,** add $4.00 per word.

General Information: A copy of your ad must be in our hands by the 13th of the fourth month preceding the date of issue (i.e. Sept issue copy must be received by May 13th). When normal closing date falls on Saturday, Sunday or Holiday, issue closes on preceding work day. Send for the classified brochure.

DEADLINES

Ads not received by our closing date will run in the next issue. For example, ads received by November 13 will appear in the March issue that is on sale January 17. ELECTRONICS NOW is published monthly. No cancellations permitted after the closing date. No copy changes can be made after we have typeset your ad. NO REFUNDS, advertising credit only. No phone orders.

CONTENT

All classified advertising in ELECTRONICS NOW is limited to electronics items only. All ads are subject to the publishers' approval. WE RESERVE THE RIGHT TO REJECT OR EDIT ALL ADS.

AD RATES: $2.50 per word, Minimum $37.50

Send you ad payments to:
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390 -- FAX
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710 -- Telephone
720 -- Test Equipment
730 -- Wanted

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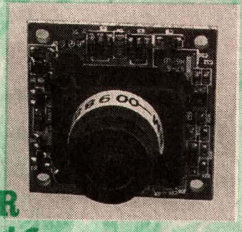

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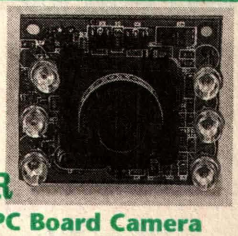

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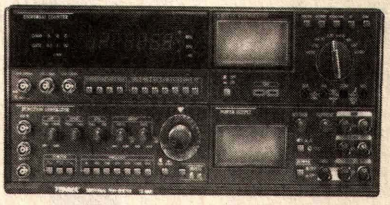

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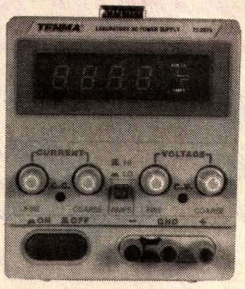

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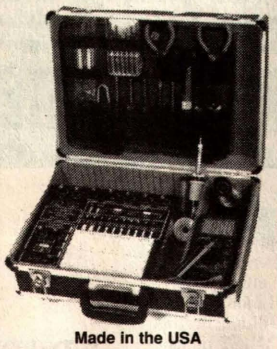

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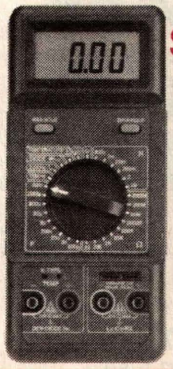

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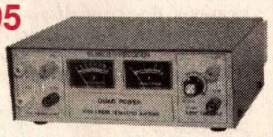

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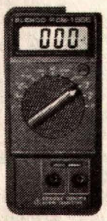

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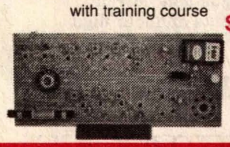

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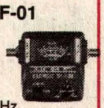

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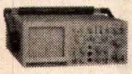

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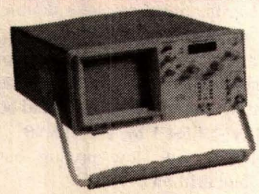

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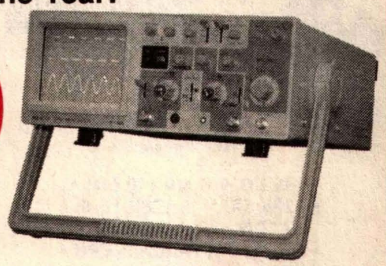

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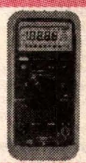

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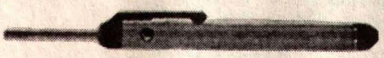

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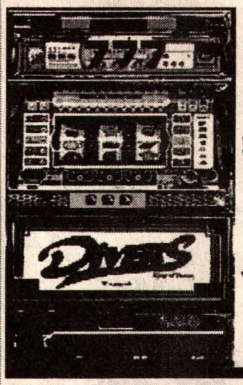

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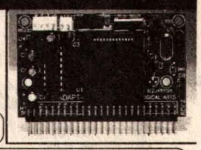

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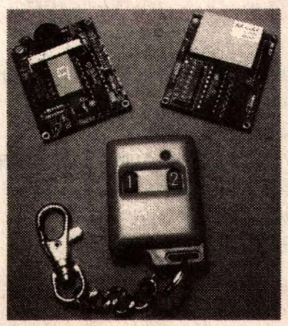

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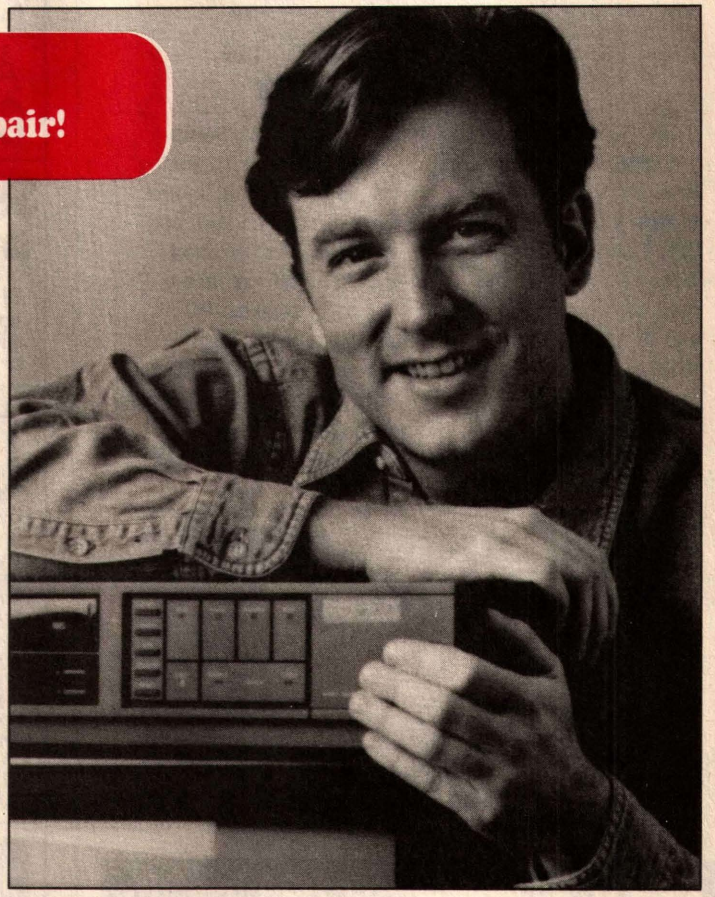

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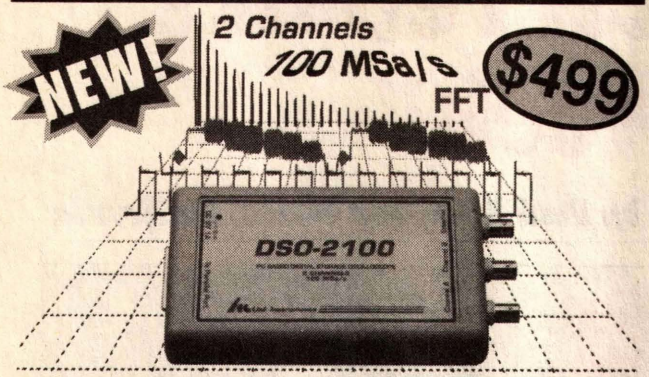

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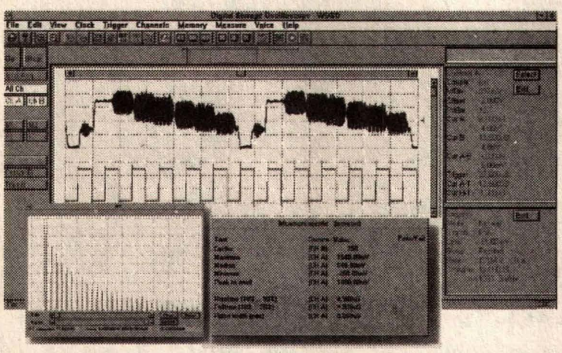

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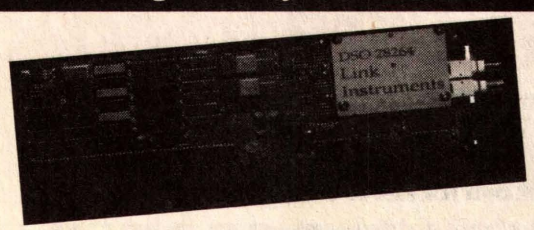

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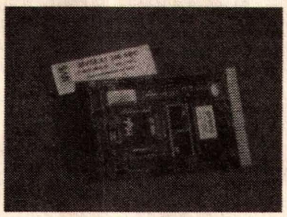

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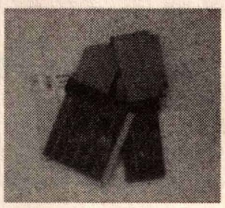

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MAX COUNTER BITS	16	18
INPUT / OUTPUT BITS	12	15
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HARDWARE INTERRUPTS	NONE	3

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PD1	3	18	PB6
XOUT	4	17	PB5
XIN	5	16	PB4
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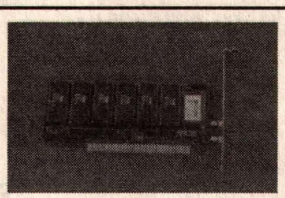

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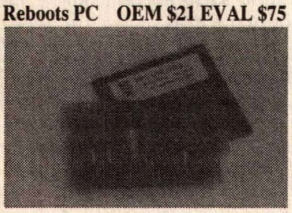

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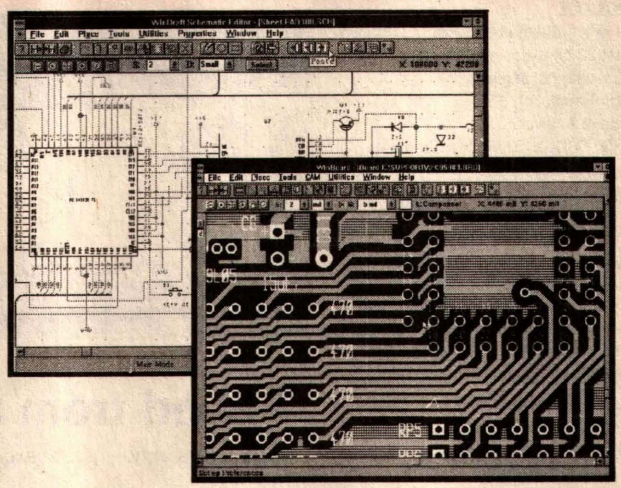

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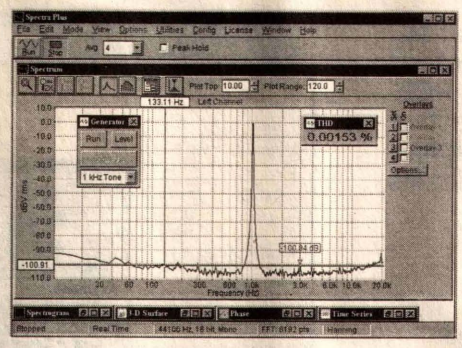

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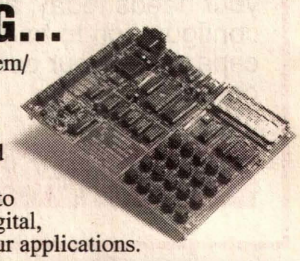

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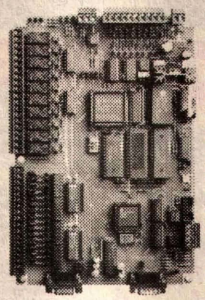

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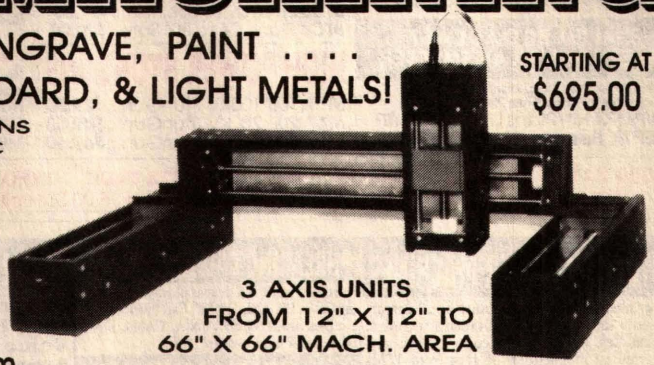

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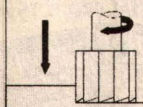

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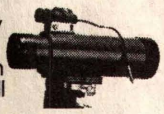

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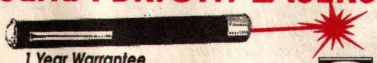

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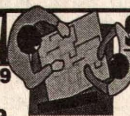

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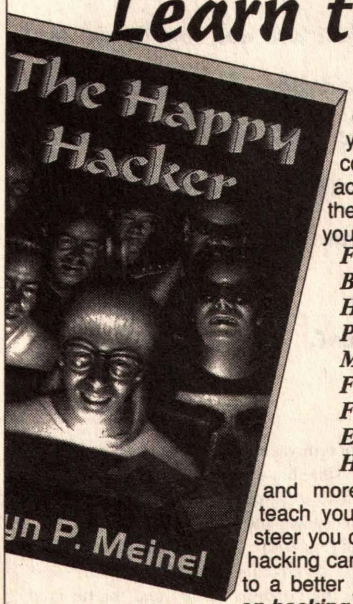

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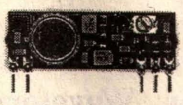

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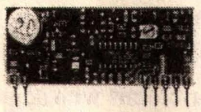

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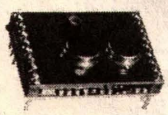

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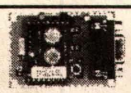

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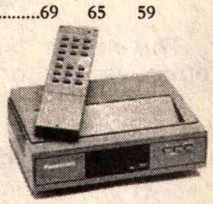

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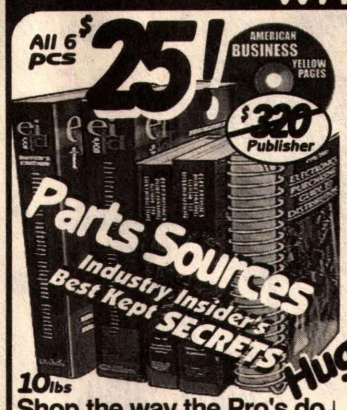

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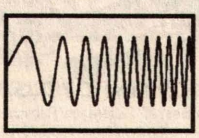

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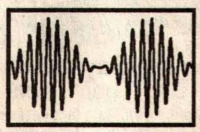

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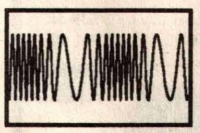

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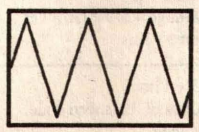

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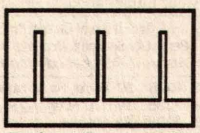

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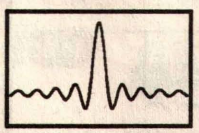

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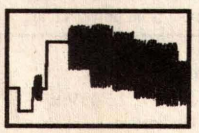

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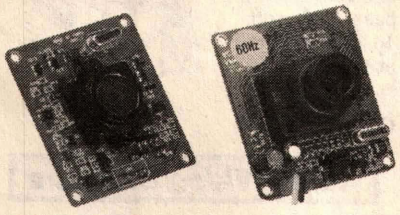

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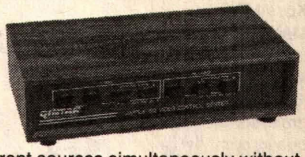

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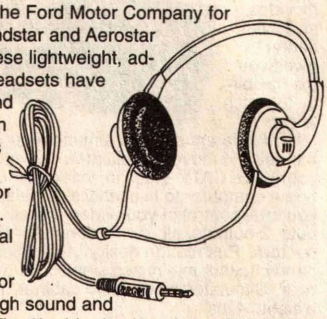

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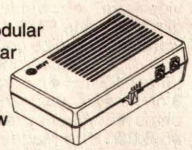

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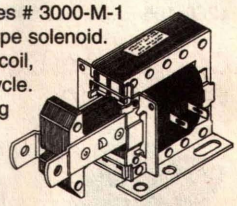

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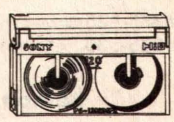

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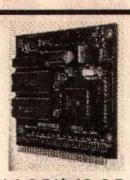

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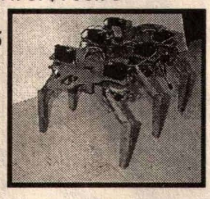

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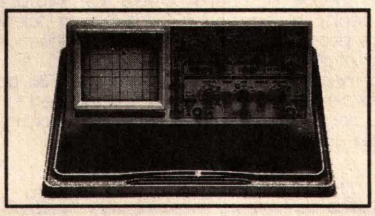

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$19.00 any qty

General

Display: 3-1/2 Digit LCD, 21mm Figure Height with Automatic Polarity
Overrange Indication: 3 Least Significant Digits Blank
Temperature for Guaranteed Accuracy: 23°C±5°CRH<75%
Temperature Ranges: Operating: 0°C to 40°C (32°F to 104°F) Storage: -10°C to 50°C (14°F to 122°F)
Power: 9V Alkaline or Carbon-Zinc Battery(NEDA1604)
Low Battery Indication: BAT on Left of LCD Display
Dimensions: 188mm long x 87mm wide x 33mm thick
Net Weight: 400g

DC Voltage (DCV)

Range:	Resolution:	Accuracy:
200mV	100µV	
2000mV	1mV	±(1%rdg+2dgts)
20V	10mV	
200V	100mV	
1000V	1V	

Maximum Allowable Input: 1000V DC or Peak AC.

DC Current (DCA)

Range:	Resolution:	Accuracy:
200µA	100nA	
2000µA	1µA	±(1.2%rdg+2dgts)
20mA	10µA	
200mA	100µA	±(1.2%rdg+2dgts)
10A	10mA	

Overload Protection: mA Input. 2A/250V fuse.

Resistance (Ω)

Range:	Resolution:	Accuracy:
200Ω	100mΩ	
2000Ω	1Ω	
20KΩ	10Ω	±(1.2%rdg+2dgts)
200KΩ	100Ω	
2000KΩ	1KΩ	
20MΩ	10KΩ	±(2%rdg+10dgts)

Maximum Open Circuit Voltage: 2.8V

Diode Test

Measures forward voltage drop of a semiconductor junction in mV test current of 1.5mA Max.

ohFE Test

Measures transistor hFE.
Frequency Range: 45Hz-450Hz
Maximum Allowable Input: 750V rms
Response: Average Responding. Calibrated in rms of a Sine Wave.

AC Voltage (ACV)

Range:	Resolution:	Accuracy:
200V	100mV	±(1.2%rdg+10dgts)
750V	1V	

CAT NO	DESCRIPTION	PRICE
9300G	Rugged High Quality DMM with Rubber Boot	$19.00

Positive Photofabrication Kit

Make your own PCB's

Kit includes the basic items needed to fabricate pre-sensitized printed circuit boards (does not include artwork). Also included is a basic process guide to assist the user in the basics of exposing, developing and etching a PCB. All items fit conveniently in the plastic development tray, and a tight fitting lid is included for handy storage. Additional recommended supplies for fabricating PCB's are: exposure bulb, etchant tank, eye protection, art-work, paper towels.

Kit Includes

- 1 each 3"x5" pre-sensitized single sided PCB
- 1 each 4"x6" pre-sensitized single sided PCB
- 1 each 6"x6" pre-sensitized single sided PCB
- 1 each 500ml developer liquid
- 1 each 500ml ferric chloride etching liquid
- 2 each foam brushes
- 1 each plastic development tray
- 1 each rubber gloves
- 1 each instruction sheet

new!

CAT NO	DESCRIPTION	PRICE
416-K	Photofabrication Kit	$27.95

Positive Photo Resist Pre-Sensitized Printed Circuit Boards

These pre-sensitized printed circuit boards are ideal for small production runs. They provide high resolution and excellent line width control. High sensitive positive resist coated on 1oz. copper foil allows you to go direct from your computer plot or art work layout. No need to reverse art.

Single-Sided, 1oz. Copper Foil on Paper Phenolic Substrate

CAT NO	DESCRIPTION	1	PRICE EACH 10	50
PP101	100mm x 150mm/3.91" x 5.91"	$2.55	$1.90	$1.70
PP114	114mm x 165mm/4.6" x 6.6"	2.98	2.45	1.98
PP152	150mm x 250mm/5.91" x 9.84"	5.40	3.98	3.60
PP153	150mm x 300mm/5.91" x 11.81"	6.15	4.48	4.10
PP1212	305mm x 305mm/12" x 12"	12.78	10.65	8.52

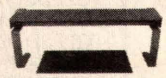
Single-Sided, 1oz. Copper Foil on Fiberglass Substrate

CAT NO	DESCRIPTION	1	PRICE EACH 10	50
GS101	100mm x 150mm/3.91" x 5.91"	$ 3.90	$2.98	$2.60
GS114	114mm x 165mm/4.6" x 6.6"	4.80	3.49	3.20
GS152	150mm x 250mm/5.91" x 9.84"	8.69	5.98	5.78
GS153	150mm x 300mm/5.91" x 11.81"	10.20	7.20	6.80
GS1212	305mm x 305mm/12" x 12"	18.88	15.73	12.59

Double-Sided, 1oz. Copper Foil on Fiberglass Substrate

CAT NO	DESCRIPTION	1	PRICE EACH 10	50
GD101	100mm x 150mm/3.91" x 5.91"	$ 5.07	$3.68	$3.38
GD114	114mm x 165mm/4.6" x 6.6"	5.95	4.29	3.99
GD152	150mm x 250mm/5.91" x 9.84"	10.47	7.39	6.98
GD153	150mm x 300mm/5.91" x 11.81"	11.95	8.69	8.30
GD1212	305mm x 305mm/12" x 12"	22.09	18.35	14.68

Exposure System



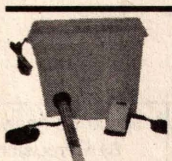
Just place your presensitized board and artwork centered under the exposure fixture. Place the convenient acrylic sheet over the board and artwork to hold everything in place. Turn on light. Voila! Exposure takes about 5 minutes. Kit includes one fluorescent tube, stand and acrylic weight.

new!

Features

- Exposes boards in about 5 minutes!
- Convenient acrylic sheet to hold board in place during exposure (12.5" x 8.5")
- Fluorescent light fixture with plastic cover designed to aid in proper light refractions for even exposure

CAT NO	DESCRIPTION	PRICE
416-X	Fluorescent Exposure System	$31.95
416-B	Extra Replacement Fluorescent Tube	16.95

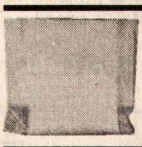


Etching Tank

This handy etching system will handle PC boards up to 8" x 9", two at a time. Ideal for etching your PCB's! System includes an air pump for etchant agitation, a thermostatically controlled heater for keeping etchant at optimum temperature and a tank that holds 1.35 gallons of etchant. A tight fitting lid is also supplied to prevent evaporation when system is not being used. Typical etching time is reduced to 4 minutes on 1oz. copper board!

REDUCES ETCHING TIME!

CAT NO	DESCRIPTION	PRICE
12-700	Etch Tank System	$37.95



Developer

This product is used as the developer on our positive photo-resist printed circuit boards. Includes instructions. 50 gram package, mixes with water, makes 1 quart.

CAT NO	DESCRIPTION	PRICE EACH 1	10	25
POSDEV	Positive Developer	$.95	$.80	$.50

Etching Chemicals/Ferric Chloride

A dry concentrate that mixes with water to make 1 pint of etchant, enough to etch 400 sq. inches of 1oz board.

CAT NO	DESCRIPTION	PRICE EACH 1	5
ER-3	Makes 1 pint	$3.50	$2.75

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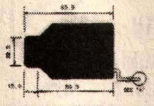
CIRCLE 332 ON FREE INFORMATION CARD

Color Weather Proof Bullet Camera

1/3" CCD with removeable rotation capable mounting bracket

new!



Specifications

Image Sensor:	Interline transfer CCD 1/3" format
Effective Pixel:	512(H)x492(V) pixels/NTSC 512(H)x582(V) pixels/PAL
Scanning System:	2 : 1 interlaced
Sync System:	Internal sync
Sync Pulse:	15.734KHz +1%(H)/15.625KHz +1%(H) 59.94Hz +1%(V)/ 50Hz +1%(V) Sub-Carrier 3.57 MHz +30ppm
Resolution:	400 TV lines (H)
S/N Ratio:	More than 46dB (typ)
Gamma Characteristics:	0.45
Min. Illumination:	1 LUX (F1.2 10 IRE)
Video Out:	Composite video signal : 1.0Vp-p
White Balance:	Auto white balance
Electronic Shutter:	1/60 - 1/100,000 SEC(N) 1/50 - 1/100,000 SEC (P)
Power Supply:	DC 12V + 10%
Power Consumption:	240mA (typ)
Lens:	4mm (78 or 92 degree) F : 2.0
Ambient Operating Temp:	-5 deg. C +40 Deg. C
Ambient Storage Temp:	-10 Deg. C+50 Deg. C RH 95% MAX
Dimension:	2 1/8" (L) x 1 1/4" (D)
Weight:	3 oz.

CAT NO	DESCRIPTION	PRICE EACH 1	5
WDB-5407S	Color Water Tight Bullet Camera	$299.00	$269.00

(water tight for outdoor use, not suitable for sustained underwater use)

CCD Bullet Cameras

new!

Available with standard or pinhole lens. Virtually indestructible bullet shaped casing. This sleek B&W camera can be mounted on walls or ceilings along narrow corridors or virtually any location for virtually any surveillance application. 0.5 lux minimum illumination with 380 lines of resolution. Even includes a built-in electronic iris for automatic light compensation.

Features

- Extremely low power consumption
- No blooming, no burning
- 0.5 LUX minimum illumination
- CCD area image sensor for long camera life
- Ultra small size allows for simple application and installation
- Built-in electronic auto iris for automatic light compensation
- Ultra compact camera

Specifications

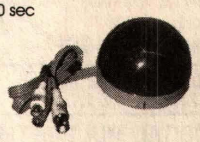
Image Pick-Up Device:	1/3" CCD area sensor
No. of Pixels:	EIA = 512(H) x 492(V)
Pixel Pitch:	EIA = 9.6uM(H) x 7.5uM
Scanning System:	EIA=525 lines, 60 field/sec
Sync System:	Internal sync
H. Resolution:	430 TU line
V. Resolution:	400 TU line
Usable Illumination:	0.5 Lux F1.6
S/N Ratio:	More than 48dB
Gamma Characteristic:	0.45
Video Output:	1.0 - 1.1 up-p 75 Ohm
Electronic Shutter Time:	EIA=1/60 - 1/50,000 sec
Lens F No. Focal Length:	STD : 1.6 Open / 4.3mm(78 deg) Pinhole: 4.3 fixed/ 2.8mm(91.4 deg)
Power Consumption:	DC 9V (8-10V), 110mA
Operational Temp.:	-10 deg - +50 deg C RH95% max
Storage Temp:	-20 deg - +60 deg C RH95% max
Dimensions:	STD : 22mm(W) x 22mm(H) x 38mm(D) Pinhole: 22mm(W) x 22mm(H) x 30mm(D)
Weight:	35g max

CAT NO	DESCRIPTION	PRICE EACH 1	5
WDB-07S	Standard Lens Version	$144.00	$129.00
WDB-07P	Pinhole Lens Version	144.00	129.00
WDP-07S/water	Standard Lens Weather Proof	169.00	152.00
WDP-07P/water	Pinhole Lens, Weather Proof	169.00	152.00

CCD Dome Camera with Audio

B&W DOME camera with integrated microphone. Ideal security system application. 12 VDC operation.

new!



Specifications

Image Device:	1/3" interline transfer CCD
Picture Elements:	EIA=542(H)x492(V)
Scanning System:	2:1 Interlace
Synchronization System:	Internal
Horizontal Resolution:	380 TV Lines
Sensitivity:	Under 0.3 LUX
Electronic Iris (linear):	EIA = 1/60~1/100,000 sec
Video Output:	1.0vp-p, 75 ohm
S/N Ratio:	More than 50dB
Power Supply:	12V DC (±20%)
Gamma:	r=1
Power Consumption:	110 mA max
Operating Temp.:	-10°C ~ +50° C
Operating Humidity:	RH 95% Max
Weight:	100g
Applied Lens:	3.6mm -92°, 4.3mm -78°
AI/EE/Flicker Less/Mirror Image:	Jump soldering selection
Audio Pick-up Sensitivity:	-60dB (0dB=1V/ubar)
Audio Frequency Range:	20 Hz ~ 20 kHz
Audio S/N Ratio:	More than 40dB
Audio Output Level:	1Vp-p/600 ohm
Dimensions:	87 x 55.5mm

CAT NO	DESCRIPTION	PRICE EACH 1	5
WDDB-6500	B&W Dome Camera	$144.00	$129.00

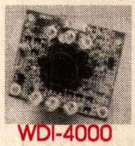
1/3" CCD Board Cameras

Available with **PINHOLE LENS** with **AUDIO**; **STANDARD LENS** with **AUDIO**; and **STANDARD LENS** with **INFRA-RED and AUDIO**. These are the world's smallest commercially available CCD board cameras!

World's Smallest B&W Board Cameras

WDP-2000

WDS-2005



WDI-4000

Specifications

Image Pick-Up Device	1/3" CCD area Sensor
Picture Elements	EIA=512(H) x 492(V)
Pixel Pitch	EIA=9.6UM (H) x 7.5UM (V)
Scanning System	2 : 1 interlace
Scanning Frequency	EIA=525 lines, 60 field/sec (II) 15.750 KHz x 60 HK
Resolution	430 Lines
Minimum Illumination	0.03 LUX
S/N Ratio	45DB
Lens Mounting	4.3mm standard, 5mm pinhole
Video Output	1.0 VP-P/750OHM composite signal
Power Requirement	8-12 VDC (9VDC standard)
Power Consumption	100mA
Operating Temperature	-20C -+ 70 C RH 95% Max
Storage Temperature	-40C -= 85 C RH 95% Max
Audio Pick-Up Sensitivity	-60 DB (0DB = 1B/UBAR. 1KNZ)
Audio Frequency Range	20 Hz to 20KHz
Audio S/N Ratio	More than 35DB
Audio Output Level	1VP-P/600 OHM

Dimensions

WDP-2000	30mm (H) x 30mm (W)
WDS-2005	30mm (H) x 30mm (W)
WDI-4000	44mm (H) x 30mm (W)

CAT NO	DESCRIPTION	PRICE EACH 1	5
WDP-2000	1/3" B&W Pinhole Lens with Audio	$89.00	$77.00
WDS-2005	1/3" B&W Standard Lens with Audio	89.00	77.00
WDI-4000	1/3" B&W Infra-RED with Audio	89.00	77.00
WDPH-55BW	Plastic Housing Option for B&W Board Cameras (WDP-2000 & WDS-2005 ONLY)	13.00	12.00

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Standard Tip

- *Auto-Temp 136ESD & Auto-Temp 137ESD*
- *Meets applicable military standards*
- *ESD safe featuring ceramic heating element and state of the art P.T.C. sensor to ensure accurate temperature performance*

Features

Fine Tune Temperature from 150° C (300° F) through 450° C (850° F) without unnecessary tip or heating element changes.
Precision "Tip Temperature" accuracy is mastered to within ±3° C (6° F) using state of the art circuit technology and a built-in P.T.C. sensor located at the top of each ceramic heater shaft for fail safe accuracy.
Fast Heat Up & Recovery. A long life Japanese made ceramic heating element facilitates fast heat up, fast recovery and exacting temperature control with minimal overshoot. Heat-up time to working temperature is attained in about 45 seconds.**Spike Free Circuit.** "Zero voltage" switching and fully grounded design meets military application standards for protection of electrosensitive devices against line transience and voltage spikes. Tip leakage is less than 0.4 mv or 0.5 ohm resistance.**External Calibration Port.** A calibration port is located on the face of the unit thus temperature adjustments are quick and convenient.
Lightweight Soldering Iron. Ergonomic mini handle that stays "cool". Handle assembly cord is made from silicone rubber that won't be damaged when coming into contact with high temperature irons.
Isolated Power Unit. The power unit is isolated from the AC line by a high quality transformer and only 24 Vac voltage is used to drive the heating element.
ESD Safe. Exceeds all soldering equipment military specifications regarding electro static sensitive devices for critical applications.
Lock-Out Feature: Constructed with a lock-out feature to allow supervisors only to set and lock specific soldering temperatures. Accomplished via a special sized allen head screw located on the front panel.**Superior High Insulation** ceramic heater provides insulation rated over 100Mohms at 750° F. **Optional SMD Tip Series** for re-work applications. **Range of Interchangeable Tips Available** for maximum system flexibility.

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136ESD

137ESD w/ Digital R/O

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CAT NO	DESCRIPTION	PRICE EACH 1	5
136ESD	Electronic Temp Controlled ESD Safe Soldering Station	$99.00	$88.00
137ESD	Electronic Temp Controlled ESD Safe Soldering Station w/ Digital Readout	129.00	114.00

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830 tie points. MB102PLT model features 3 binding posts and aluminum backplate.

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MB102	5.95	5.00
MB102PLT	8.95	8.00

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1/4W 5% film. 5 pieces each of 73 values. 365 pieces total. **$3.95**

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PN2222 10 Min.	6¢ ea.
Red LED T 1¾ 10 Min.	6¢ ea.
Green LED T 1¾ 10 Min.	7¢ ea.
Yellow LED T 1¾ 10 Min.	8¢ ea.
Photo Cell 10 Min.	65¢ ea.
100K Pot., 1" Shaft PC Mt. 10 Min.	15¢ ea.

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HIGH PERFORMANCE #060501 **$5.25**

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1 LB. 60/40 Solder Roll .031" **$5.95**

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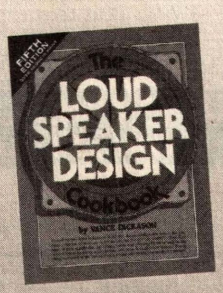

Beginner's Guide to Tube Audio Design
by Bruce Rozenblit
Terrific introduction to designing audio circuits with tubes, de-mystifies this old and new-again technology!
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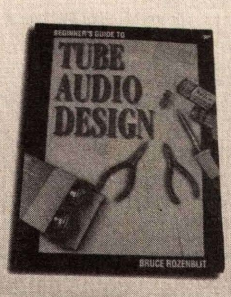

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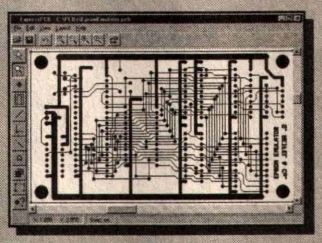

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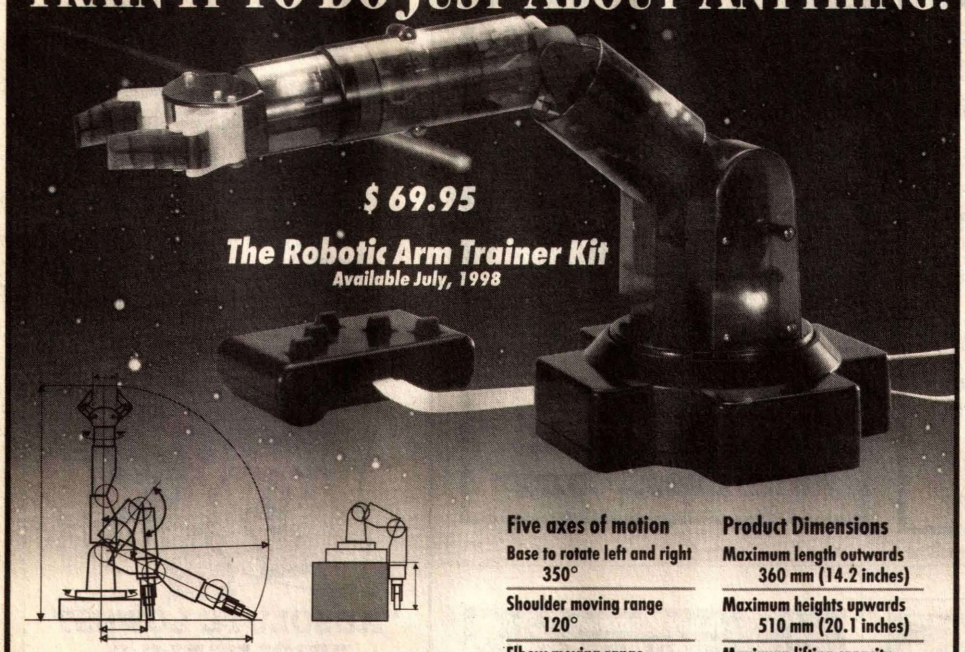

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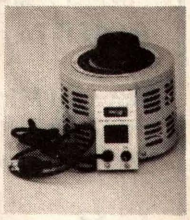

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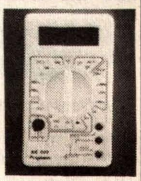

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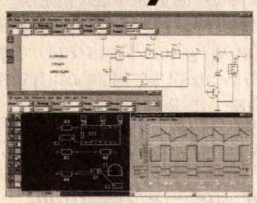

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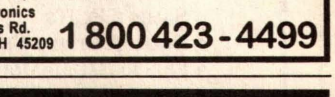

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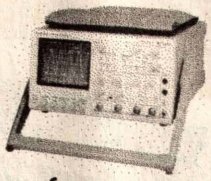

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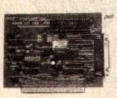

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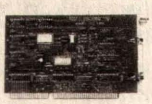

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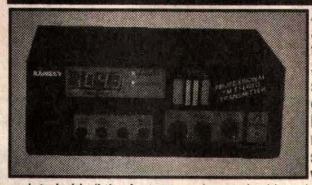


A truly professional frequency synthesized FM Stereo transmitter station in one easy to use, handsome cabinet. Most radio stations require a whole equipment rack to hold all the features we've packed into the FM-100. Set frequency easily with the Up/Down freq buttons and the big LED digital display. Plus there's input low pass filtering that gives great sound no matter what the source (no more squeals or swishing sounds from cheap CD player inputs!) Peak limiters for maximum 'punch' in your audio - without over modulation, LED bargraph meters for easy setting of audio levels and a built-in mixer with mike and line level inputs. Churches, drive-ins, schools and colleges find the FM-100 to be the answer to their transmitting needs, you will too. No one offers all these features at this price! Kit includes cabinet, whip antenna and 120 VAC supply.

We also offer a high power export version of the FM-100 that's fully assembled with one watt of RF power, for miles of program coverage. The export version can only be shipped outside the USA, or within the US if accompanied by a signed statement that the unit will be exported.

FM-100, Professional FM Stereo Transmitter Kit.....$299.95
FM-100WT, Fully Wired High Power FM-100.....$429.95

AM Band Radio Transmitter

Ramsey AM radio transmitters operate in the standard AM broadcast band and are easily set to any clear channel in your area. Our AM-25, 'pro' version, fully synthesized transmitter features easy frequency setting DIP switches for stable, no-drift frequency control, while being jumper setable for higher power output where regulations allow. The entry-level AM-1 uses a tunable transmit oscillator and runs the maximum 100 milliwatts of power. No FCC license is required, expected range is up to 1/4 mile depending upon antenna and conditions. Transmitters accept standard line-level inputs from tape decks, CD players or mike mixers, and run on 12 volts DC. The Pro AM-25 comes complete with AC power adapter, matching case set and bottom loaded wire antenna. Our entry-level AM-1 has an available matching case and knob set for a finished, professional look.

AM-25 Professional AM Transmitter Kit.....$129.95
AM-1 Entry level AM Radio Transmitter Kit.....$29.95
Cam Matching Case Set for AM-1.....$14.95

Tone-Grabber Touch Tone Decoder / Reader

Dialed phone numbers, repeater codes, control codes, anywhere touch-tones are used, your TG-1 will decode and store any number it hears. A simple hook-up to any radio speaker or phone line is all that is required, and since the TG-1 uses a central office quality decoder and microprocessor, it will decode digits at virtually any speed! A 256 digit non-volatile memory stores numbers for 100 years - even with the power turned off, and an 8 digit LED display allows you to scroll through anywhere in memory. To make it easy to pick out numbers and codes, a dash is inserted between any group or set of numbers that were decoded more than 2 seconds apart. The TG-1 runs from any 7 to 15 volt DC power source and is both voltage regulated and crystal controlled for the ultimate in stability. For stand-alone use add our matching case set for a clean, professionally finished project. We have a TG-1 connected up here at the Ramsey factory on the FM radio. It's fun to see the phone numbers that are dialed on the morning radio show! Although the TG-1 requires less than an evening to assemble (and is fun to build, too!), we offer the TG-1 fully wired and tested in matching case for a special price.

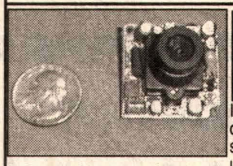
TG-1, Tone Grabber Kit.....$99.95
CTG, Matching Case Set for TG-1 Kit.....$14.95
TG-1WT, Fully Wired Tone Grabber with Case.....$149.95
AC12-5, 12 Volt DC Wall Plug Adapter.....$9.95

The Cube World's Smallest TV Transmitter

Perfect video transmission from a transmitter you can hide under a quarter and only as thick as a stack of four pennies- that's a nickel in the picture! Transmits color or B&W up to 150' to any TV tuned to cable channel 59 with a solid 20 mW of power. Crystal controlled for no frequency drift with performance that equals law enforcement models that cost hundreds more! Deluxe model includes sound using a sensitive built-in mike that will hear a whisper 15 feet away! Units run on 9 volts and hook-up to most any CCD camera. Our cameras shown below have been tested to mate perfectly with The Cube and work great. Fully assembled.

C-2000 Video Transmitter Cube.....$89.95
C-3000 Video and Audio Transmitter Cube.....$149.95

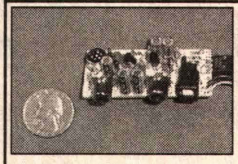
CCD Video Cameras



If you're looking for a good quality CCD board camera, stop right here! Our cameras use top quality Japanese Class 'A' CCD arrays, not the off-spec arrays that are found on many other cameras. You see, the Japanese suppliers grade the CCDs at manufacture and some manufacturers end up with the off-grade chips due to either cost constraints or lack of buying 'clout'. These cameras have nice clean fields and excellent light sensitivity, you'll really see the difference, and if you want to see in the dark, these are super IR (Infra-Red) sensitive! Available with Wide-angle (80°) or super slim Pin-hole style lens. Both run on 9 VDC and produce standard 1 volt p-p video. Add one of our transmitter units for wireless transmission to any TV set, or add our Interface board (below) for Audio sound pick-up and direct wire connection to any Video monitor or TV video/audio input jacks. Fully assembled.

CCDWA-2 CCD Camera, wide-angle lens.....$99.95
CCDPH-2 CCD Camera, slim fit pin-hole lens.....$99.95
IR-1 IR Illuminator Kit.....$24.95

CCD Camera Interface Board



Here's a nifty little kit that eases hook-up of your CCD camera module to any video monitor, VCR or video input TV set. The board provides a voltage regulated and filtered source to power the camera (CCD Cameras require a stable source of power for best operation), sensitive electret condensor mike for great sound pick-up and RCA Phono jacks for both audio and video outputs. Runs on 11 - 20 VDC.

IB-1 Interface Board Kit.....$14.95

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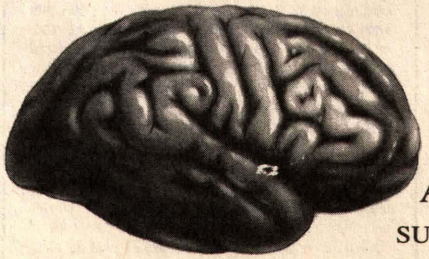

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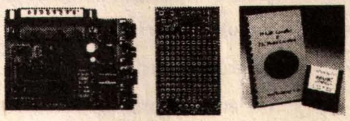

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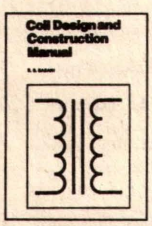

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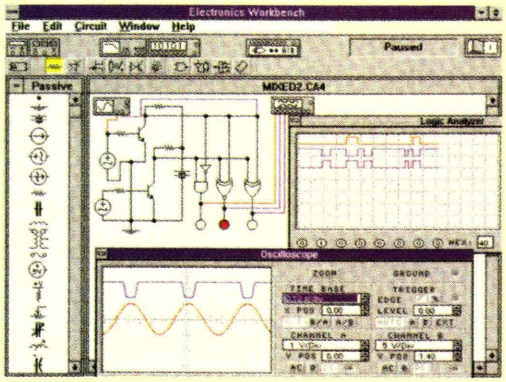

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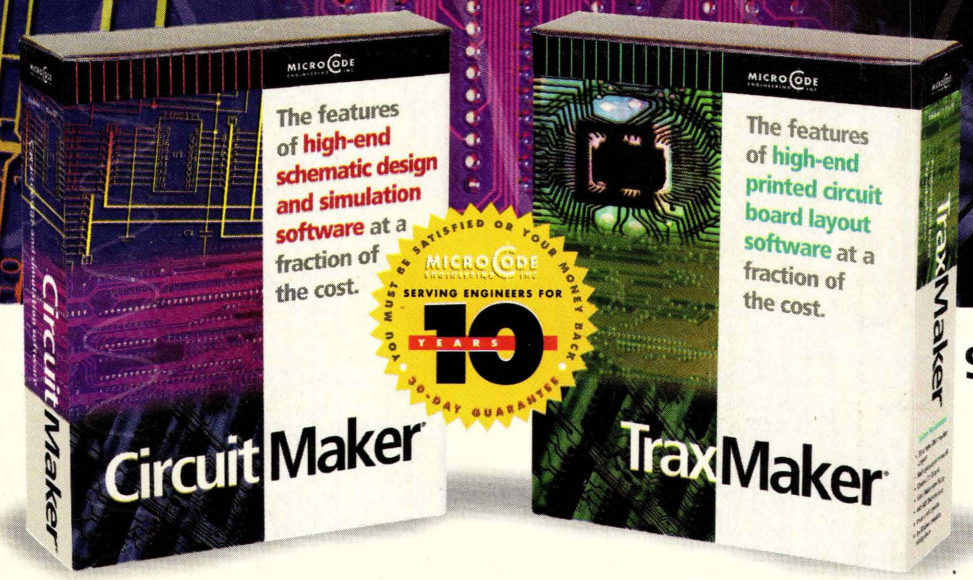
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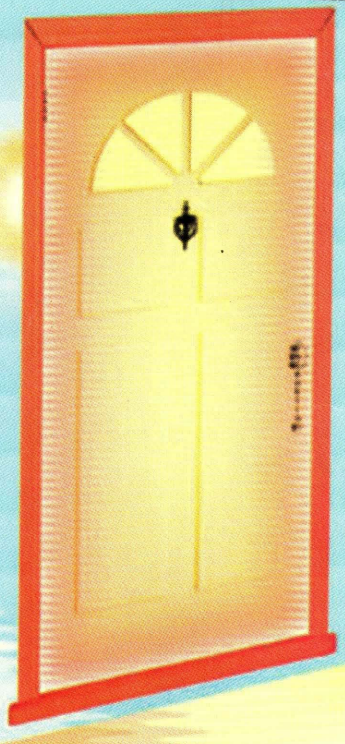

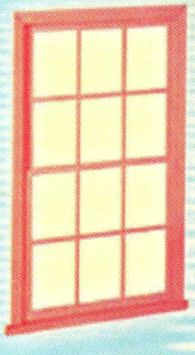

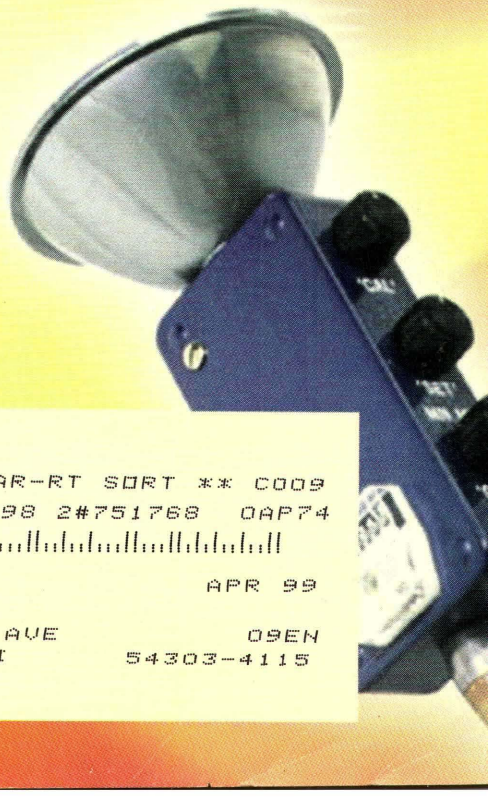

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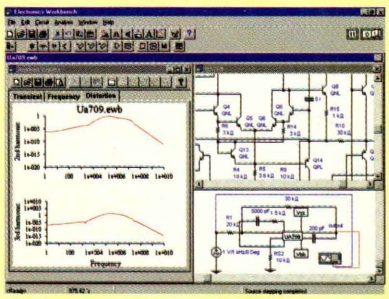

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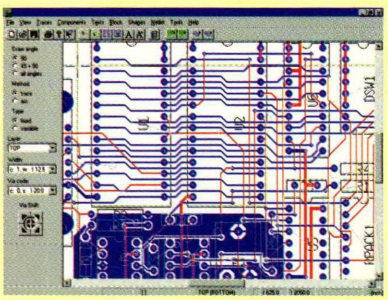

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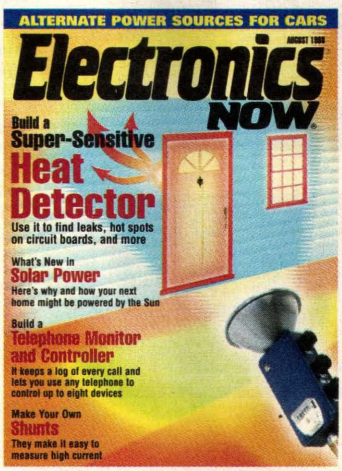
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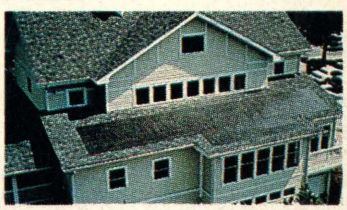
17 PROTOTYPE

Pinpointing lightning strikes in seconds, coming closer to sustainable nuclear fusion, using ultrasound to improve tire safety, and more.

51 MAKE YOUR OWN SHUNTS

They're nearly as accurate as the commercial units, but cost a lot less. — *Dean F. Poeth II, Ph.D., K8TM*

53 WHAT'S NEW IN SOLAR POWER



New technologies and initiatives are bringing down the cost of solar-power systems, and making them a lot more attractive to look at. — *Bill Siuru*

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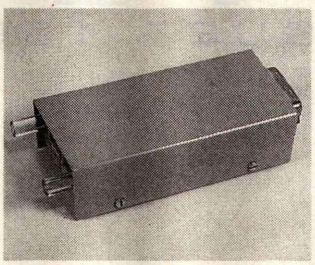

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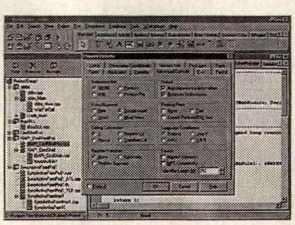

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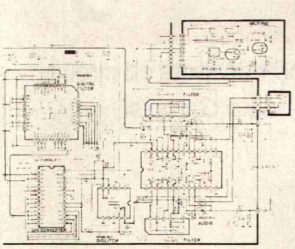

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150543	PICBasic pro compiler	$249.95

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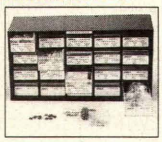
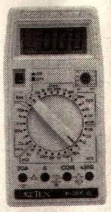


Kits include the most popular components with extra space for your customized expansion. Each kit includes a 20 drawer component cabinet.

More kits available – call for details!

Part No.	Description	Price
84953	330 pc. 7400 series IC kit	$129.95
84961	420 pc. 74LS series IC kit	119.95
84970	300 pc. CD4000 series IC kit	84.95
84988	385 pc. Linear series IC kit	159.95
108329	540 pc. 1/8 watt Resistor kit	29.95
81832	540 pc. 1/4 watt Resistor kit	28.95
107879	540 pc. 1/2 watt Resistor kit	32.95
108433	2200 pc. Electr. Hardware kit	39.95
81867	110 pc. Radial Capacitor kit	34.95
81859	320 pc. Ceramic Capacitor kit	29.95
81883	160 pc. Mylar Capacitor kit	34.95
81841	129 pc. Tantalum Capac. kit	49.95
82587	270 pc. Diode kit	39.95
82595	180 pc. Transistor kit	49.95

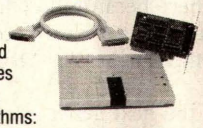
METEX® 3 1/2-Digit Digital Multimeter



- 3 1/2-digit LCD (.5" high digits)
- AC voltage: 200mV, 2V, 20V, 200V, 700V
- DC voltage: 200mV, 2V, 20V, 200V,1000V
- AC & DC current: 20µA, 200µA, 2mA, 20mA, 200mA, 2A, 20A
- Resistance: 200Ω, 2KΩ, 20KΩ, 200KΩ, 2MΩ, 20MΩ • Input impedance: 10MΩ
- Auto zeroing • One-year warranty

Part No.	Product No.	1-4	5-9
27115	M3800	$39.95	$35.95

1 Socket 16KB-8MB E(E)PROM Programmer



- Programs EPROMs, EEPROMs, and Flash memories
- Programming speeds/algorithms: normal, intelligent, and quick pulse

Part No.	Description	Price
132468	16Kb-8Mb E(E)PROM prog.	$199.95

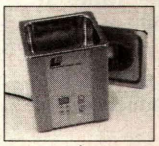
DATA I/O Universal 8KB-8MB EPROM Programmer

Parallel Port, DOS/Win 3.1®/Win® 95

- Programs 8 and 16-bit EPROMs up to 8MB, paged EPROMs, EEPROMs, serial EEPROMs (including 8-pin), flash devices, NVRAMs, bi-polar PROMs, PALs, GALs, PEELs, PALCEs, EPLDs
- Package supports DIPs up to 48-pin
- Robust memory and logic editing features

Part No.	Description	Price
145365	EPROM prog. Special	$949.95

Ultrasonic Steri-Cleaner



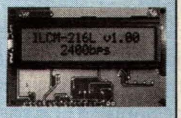
Cleans small submergible items with hard to reach corners!

- Operating frequency: 46kHz
- Tank capacity: 0.5 gallons • One-year warranty

Part No.	Description	1-4	5-9
149841	Steri-cleaner	$249.95	$224.95

Serial LCD Module

16 Characters x 2 Lines Integrated Display

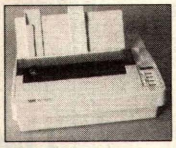


- EEPROM storage of settings, six custom characters
- One-year warranty
- Module size: 3.2"L x 2.0"W x 0.5"T

Part No.	Description	Price
150990	LCD module Special	$53.95

DEC Writer 95 Printer

Windows® 95 Compatible



- Impact dot-matrix with 24 wire print head
- Epson and IBM emulation character set
- 13 fonts built-in
- Includes sheet feeder, manual and drivers (Windows® 3.1 & 95) • Weight: 14.0 lbs.
- Size: 15.9"W x 12.6"D x 5.4"H

Part No.	Description	Price
151618	DEC writer 95.	$79.95

PARALLAX Basic Stamps

127693 130892

Basic Stamps are small computers using a variation of Basic, called PBASIC to control execution of many applications. The BS1-IC has 8 I/O lines, while the BS2-IC has 16 I/O lines which can be connected directly to buttons, LEDs, registers, and many other TTL level devices. • One-year warranty

Part No.	Description	Price
127693	Basic stamp BS1-IC	$34.95
130892	Basic stamp BS2-IC	49.95

Encyclopedia of Electronic Circuits on CD-ROM

Tab/McGraw-Hill Features 1,000 circuitry drawings from the 5-volume printed set. Fully searchable.

- Weight: 0.5 lbs.

Part No.	Description	1-4	5-9
130500	Encyclopedia	$99.95	$89.95

Flashing LED Sweetheart Kit

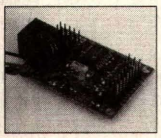
Shows a beating heart!

- Operating voltage: 8 to 15VDC
- Power consumption: 8mA
- Size: 2.5"L x 2.4"W x 1.2"H

Part No.	Description	1-4	5-9
147555	MK101 mini kit	$11.95	$10.95

Mini SSC II Module

(Serial Servo Controller)



- Controls 8 pulse-proportional servos
- Receives at 2400 or 9600 baud
- Modular input RJ11
- One year warranty
- Size: 1.9"L x 1.4"W

Part No.	Description	1-9	10-99
151001	SSC II module	$49.95	$44.95

EDWin NC (CAD/CAE) Software

The first truly seamlessly integrated suite of software running in all Windows® formats…simulation, schematics, and PCB design. Large start-up libraries.

Part No.	Description	1-4	5-9
141680	EDWin NC	$149.95	$134.95

Weller® 40-Watt Electronic Soldering Station

- 40 watts, 120V @ 60Hz
- Lighted on/off switch
- Adjustable power from 5 watts - 40 watts
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- Includes ST3 1/8" screwdriver tip, soldering station, soldering handle and manual

Part No.	Description	Price
146595	40 watt soldering station	$44.95

69 Piece Professional Jumbo Tool Kit

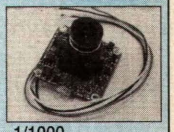
Comprehensive Kit for Field Technicians and Engineers!

- Size: 18.5"L x 13.8"W x 6.7"H • Wt.: 22.8 lbs.

Part No.	Description	Price
149024	Prof. tool kit Special	$219.95

Jameco Camera Board

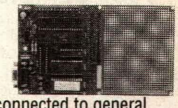
Sony Chipset



- EIA system 537(H) x 505(V)
- Composite output with 420 line resolution
- Shutter speed: 1/60 - 1/1000
- Requires 12V power source (not included) • One-year warranty
- Size: 1.3"L x 1.3"W x 1.0"H

Part No.	Description	Price
150931	Camera board Special	$74.95

8031 Embedded Applications Proto PC Board



- 32KB of SRAM
- 32KB of monitor EPROM
- 8031 CPU
- 14 screw-type terminal blocks connected to general purpose digital input/output ports
- 40-pin header for all system signals
- Two 23-pin headers for demultiplexed data, address, control, and I/O signals
- Size: 7.0"L x 4.0"W • One-year warranty

Part No.	Description	Price
119546	Prototype PC board	$99.95

Jameco Solderless Breadboards

20773

- Low static plastic body – CMOS safe
- Nickel plated clips designed to withstand up to 5,000 insertion cycles

Part Number	Contact Points	Size L x W	1-9	10-49
94457	100	6.5 x 0.4	$2.49	$2.25
20600	400	3.3 x 2.1	4.95	4.49
136901	1,600	5.5 x 2.3	21.95	19.95
20669	630	6.5 x 1.4	5.49	4.95
20722	830	6.5 x 2.1	7.95	6.95
20757	1,360	6.5 x 3.1	11.95	10.95
20773	1,660	6.5 x 4.3	17.95	15.95
20790	2,390	6.9 x 5.8	22.95	20.49
20811	3,220	7.3 x 7.5	30.95	27.95

Robots, Androids and Animatrons (1997)

McGraw-Hill This book demonstrates how to put together the latest in robotics technology.

Part No.	Product No.	1-4	5-9
150498	Robots, Androids	$19.95	$17.95

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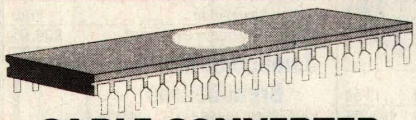

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EDITORIAL

I Object

Before I start, let me make one thing clear: I am not a real big fan of Microsoft. So, you can imagine how surprised I am to find myself defending them in this space. Then again, since I am defending them against the government, well . . .

Our society is based on the principle of free enterprise. Yes, Microsoft is in the powerful position it is in today thanks in part to shrewd, aggressive, and perhaps ruthless marketing. It is also there because they have devised an operating system that fills the needs of most users better or more economically than their current competitors (Unix, Linux, OS/2, and Macintosh). Maybe someday that will change.

Win98 is slated to be the next generation in their operating system family. Not so much a revolutionary change, it is more of an updating and tweaking of Win95. One of the critical improvements was the integration of the already available Active Desktop. That feature provides, among other things, a seamless integration between a user's PC desktop and the Internet, making using the resources available on the Internet an easier and more intuitive operation. Of course, to do that, the desktop needs a browser component. Naturally, Microsoft chose to use its own Internet Explorer (IE) browser for that.

At least that was the plan before the government stepped in. As this is being written, the Justice Department along with a slew of State Attorney Generals have filed suit accusing Microsoft of violating anti-trust laws and seeking to block the release of Win98 unless either Internet Explorer is deleted from it or Netscape's browser is bundled with it to give consumers a choice. For obvious reasons, neither choice is acceptable to Microsoft.

The government means well, but as usual when it comes to technology, they are misguided. There was a monopoly in the browser market—it belonged to Netscape prior to Microsoft's entry into the field. Even today, Netscape by the government's own figures, still has 60% of the market. And the presence of IE in the operating system does not stop users from using Netscape if they wish. Its presence is well advertised on the Net, and getting a copy is easy and free (although the latter was not the case prior to the introduction of IE).

Other points are equally weak. For example, the suit makes a big deal about the "Channel" bar that highlights content providers with ties to Microsoft. But you know what, Netscape comes with Netcaster, which is pretty much the same thing, with the same types of problems. Fortunately, disabling such "features" is easy enough, if you wish.

What annoys me here is that the suit seems to be the government's way of saying that computer users are dolts, unable to use anything other than the tools put in front of them. Just because it comes bundled with your system, you are under no obligation to use IE, or any other bundled app for that matter. Of course, if you have any degree of computer literacy, you already know that. If not, I guess you sue.

Carl Laron

Carl Laron
Editor

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Ideal for measurements on televisions, cars, digital circuits and pulse generators. Automatic setup. Select normal, auto or single as the trigger mode. Automatic power shutdown feature. (Auto shutdown can be disabled.) Requires six "AA" batteries or AC adapter. (*Mfr. Warranty:* one-year limited. *Size:* 9×5.1×1.7" (HWD). *Weight:* 5 oz., excluding batteries.)

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CIRCLE 134 ON FREE INFORMATION CARD

LETTERS

SEND YOUR COMMENTS TO THE EDITORS OF ELECTRONICS NOW MAGAZINE

Oooops!

I was examining the schematic and PC board in the article "Build an AM Transmitter" (June, 1998), and believe I have uncovered a problem. In the schematic, resistor R45 is shown grounded. However, on the board, it is shown wired to the cathode of D8. Which is correct?

JAY CRASWELL
Jordan, MN

The PC board is correct. In preparing the art for publication, the connection from the bottom of R45 was drawn too long. It actually terminates at the line above the one shown, which goes to D8 as per the board. We are sorry for any confusion that might have been caused—Editor

Where Are the Indexes?

Hello. I have been a long time subscriber to your magazine. I noticed that, unlike recent years, you did not publish an Annual Index. I do recall reading somewhere that you have moved the indexes to your Internet site, but I was unable to locate them. Can you help?

D. SMITHSON
via e-mail

Sure: A searchable index of all articles that have appeared in ***Electronics Now*** *(and* ***Popular Electronics)*** *since September 1994 is available on the Gernsback Publications Web site (www.gernsback.com). You can get to it off the main* ***Electronics Now*** *page on that site. If you want to go directly to the index, the URL for the search page (no-frames version) is www.gernsback.com/noframe/en/html/ENaisearch_nf.html—Editor*

Still Disaffected

I read with considerable annoyance your June 1998 editorial: "The Object of Disaffection," which you say is based on your receiving letters, phone calls, and e-mail regarding the lack of source code for microcontrollers. I presume that I am one of the people you are referring to in the editorial. However, my complaints have never been directly referencing the availability of source code, instead my complaints have been about the impossibility of building the projects without buying the kits advertised by your authors. Not only has the lack of source code for microcontrollers been a problem, but also code (object, source or otherwise) for PC interfaces and PLDs. None of these points were addressed in your editorial.

In your editorial, you say "While our policy is to insist that any software required to make a project operate as described be made available, which in the case of microcontrollers means the object code as a minimum...". While not ideal, this would be acceptable, but I do not see any evidence that this is the case.

I've just checked your web page and for **Electronics Now**, the project code on the web page was last updated on September 16, 1997 and for **Popular Electronics,** the project code was last updated on July 25, 1997. This means that any readers who are unable or unwilling to buy the kits that are advertised in your magazine, cannot reproduce the projects you've presented in your magazine, even though the authors have been paid by you (and us, indirectly) to release the information required to build the projects. For example, in a June 1998 article entitled "Add a Video Trigger to your Oscilloscope", you publish bare board foil patterns, but don't give PLD information or microcontroller object code. This is a very interesting project that, as far as I can see, the reader cannot reproduce without buying the kit from the author!

This experience has been quite frustrating for me as I do not feel like my concerns have been adequately addressed.

MICHAEL PREDKO
via e-mail

As per the article, the required file, vidtrig.zip, is posted on the ftp site. However, I believe I know what has happened here. Shortly after the ftp site was set up, readme files were posted that listed the available articles in each directory. Unfortunately, though new files were being uploaded every month, the readme files were not being updated. Though this is the first anyone has complained, at least to us, we do need to get them up-to-date, and it will be done right away. Please accept our apologies for any confusion that was caused by this oversight.

On another note: We understand why many readers object to purchasing kits or parts solely from one source. Because of that, we insist that authors provide sources for parts other than the kit/part supplier mentioned in the article, and provide all software required to make a project function as described. On the other hand, our experience has been that oft times, the cost of the kits is less than what a typical hobbyist would need to spend to acquire the parts on his or her own, especially when you consider the high minimum orders many parts distributors require these days. Yes, if you have access to a large reserve of parts, "rolling your own" can save you a bit of money, but that is not always the case, and even less so if all parts must be obtained new through traditional channels.

Anyway, the point is that whether you want to buy a kit (when offered) or go it alone is up to you. We do our best to give you the tools you need to succeed regardless of the path you choose.—Editor EN

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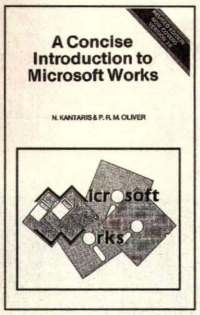

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☐ **BP350–Electronic Board Games $8.99.** Twenty novel electronic board games that you can build from the plans in this book. Whether you are interested in motor racing, searching for buried treasure on a barren island or for gold in Fort Knox, spinning the wheel of fortune, or doing a musical quiz—there is something for you to build and enjoy!

☐ **BP378-45–Simple Electronic Terminal Block Projects $8.99.** Contains 45 easy-to-build electronic projects trhat can be built by an absolute beginner. Projects are assembled on terminal blocks using only a screwdriver and other simple hand tools. No soldering is required.

☐ **BP432–Simple Sensor Terminal Block Projects $8.99.** This book is the next logical step from *45 Simple Electronic Terminal Block Projects* (BP378), by the same author. The former describes an easy method of constructing transistor circuits without the need for soldering. It is an *open sesame* to the practical world of electronics for youngsters or beginners.

☐ **BP428–MS-Word 97 Explained $12.75.** Without any previous knowledge of MS-Word, you can be up and running this evening using this basic text as a guide! Nothing is assumed! The hardware specification you need to run the package, and how to install it onto your system, are covered. You discover how to enter, edit and enhance text and how to become comfortable working with document pate layouts, paragraph styles, document templates, textboxes and frames.

☐ **BP367–Electronic Projects for the Garden $8.99.** Electronics enters the Garden! New exciting book points out how gardeners can build simple gadgets to promote success where the elements work against you. Some of the projects are: over/under temperature monitoring, dusk/dawn switching, automatic plant watering, warming cables, etc.

☐ **BP368–Practical Electronics Musical Effect Units $8.99.** There is a constant hullabaloo for musical effects projects by the hobbyist community. This book provides practical circuits for several projects that range in complexity and are sure to work. All the circuits are easy to build and use readily-available parts.

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☐ **BP393–Practical Concise Introduction to UNIX $8.99.** If you are using or intend to use the UNIX multi-user operating system and want to get the most out of your computer system in terms of efficiency and productivity, then you must learn its operating system. The book explains how the UNIX operating system is structured so that you understand what happens when you first approach your computer.

☐ **BP396–Electronic Hobbyists Data Book $10.99.** This book provides a wide range of data. If, for example, you require details of a modern five-band resistor code or an old color code for a ceramic capacitor, the formula for parallel resistance, or basic data on an NE5534AN operational amplifier, it is contained within these pages. The subjects covered are numerous and widespread to cover all hobbyist interests.

☐ **BP343–A Concise Introduction to Microsoft Works for Windows $10.99.** The book explains and details: How the Works for Windows package fits into the general Microsoft Windows environment; how to use the word processor to advantage; how to use Microsoft Draw to create and edit graphics and place them in your documents; how to build up simple spreadsheet examples; and how single, and multiple charts, or graphs, of different types can be generated. And there's much more!

☐ **BP282–Understanding PC Specifications $8.95.** This book explains PC specifications in detail, and the subjects covered include the following: Differences between types of PC (XT, AT, 80386, 80486, Pentium etc.); math co-processors; input devices (keyboards, mice, and digitizers); memory, including both expanded (EMS) and extended RAM; RAM disks and disk caches; floppy disk drive formats and compatibility; hard disk drives; and display adapters (CGA, Hercules, super VGA, etc.).

☐ **BP298–Concise Intro to the Macintosh System and Finder $7.50.** Although the Mac's WIMP user interface is designed to be easy to use, much of it only becomes clear when it is explained in simple terms. The book explains: The System and Finder, what they are and what they do; how to use the System and Finder to manipulate disks, files and folders; configuring and printing files from the Finder; getting the most from the system utility programs; and running MultiFinder.

☐ **BP88–How To Use OP Amps $7.50.** The Operational Amplifier is the most adaptable circuit module available to the circuit designer. It is possible to purchase a low-cost integrated circuit with several hundred components, very-high gain and predictable performance. This book has been written as a designer's guide for most Operational Amplifiers, serving both as a source book of circuits and a reference book for design calculations.

☐ **BP316–Practical Electric Design Data $10.95.** A builder's bargain book–a comprehensive ready-reference manual for electronic enthusiasts with over 150 practical circuits. It covers the main kinds of components (from pig-tail leads to surface mount), pin-outs, specs and type selection. Basic units are defined and most used formulae explained. Five additional sections are devoted to circuit design, covering analog, digital, display, radio and power supply circuits.

☐ **BP346–Programming in Visual Basic for Windows $10.99.** This book is a guide to programming. The reader is not expected to have any familiarity with the language as both the environment and statements are introduced and explained with the help of simple programs. The user is encouraged to build these, save them, and keep improving them as more complex language statements and commands are encountered.

☐ **BP341–MS-DOS 6 Explained $12.25.** The book covers: How the DOS operating system of your computer is structured so that you can understand what happens when you first switch on your computer; How directories and subdirectories can be employed to structure your hard disk for maximum efficiency; how to use the DOS Shell program, and much, much more.

☐ **BP345–Getting Started In Practical Electronics $8.99.** If you are looking into launching an exciting hobby activity, this text provides basic essentials for the builder and 30 easy-to-build fun projects with which every experimenter should toy. Printed-circuit designs are included to give your project the professional touch.

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Q & A

READERS' QUESTIONS, EDITORS' ANSWERS

Pinball Wizard Correction

Contrary to what we said in the May 1998 installment of "Q&A," the fine folks at Two Bit Score, Austin, Texas, do NOT repair, or supply parts for, Gottlieb pinball games. They do service most of the other leading makes. For more information see their web site at www.twobit.com. If anyone knows of a supplier of Gottlieb parts, do please let us know.

Dawn Simulator

Q *I would like to have a 120-volt AC circuit controlled by a clock radio so that when the clock switches the radio on, a 100-watt bulb will start very dim and brighten over a period of about 30 seconds. — F. P., Orland Park, IL*

A What you want is called a "dawn simulator" and is sometimes used to treat sleep disorders; it's a very gentle, natural way to wake a person up. Some dawn simulators take as long as 30 minutes (not 30 seconds) to bring the lights up to full brightness.

As you know, a light dimmer works by cutting off part of each AC cycle. This is done by triggering a Triac (AC switch) after part of each cycle has already passed by. The best way to build a dawn simulator would be to use a microcontroller to compute the exact time delay during each cycle, changing it slowly over a period of minutes. If there's sufficient interest, we might develop this as a construction project later; it would provide very smooth, reliable operation.

In the meantime, Fig. 1 shows an all-analog circuit that you can build. It's a modernized version of a circuit originally published by General Electric that used a unijunction transistor and a pulse transformer, both of which are hard to get nowadays.

Diodes D1-D4, resistor R1, and diode D5 produce a pulsating DC waveform clamped to 15 volts; almost a square wave. From that, the circuit derives two more waveforms, a sawtooth across C1 and a slowly rising voltage across C2. Those are combined, amplified by Q1 and Q2, and then used to control the Triac (TR1) through an optocoupler.

Switch S1 lets you start the timing cycle over again—a necessity while you are testing the circuit. The circuit is somewhat tricky, and you should breadboard it before building the final version. Adjust R4 so that the light bulb just goes off when S1 is pressed; you'll find that R4 affects the behavior of the circuit quite a bit. Change C2 to change the timing period; for a true dawn simulator, you may want to make C2 as large as 3200 mF. Use a smaller value while experimenting so you don't have to wait half an hour to see what's going to happen.

Most of the other parts aren't critical.

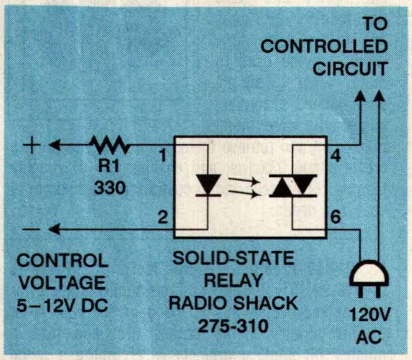

FIG. 2—USE THIS APPROACH TO INTERFACE the dawn simulator with a clock radio. The leads marked "Control Voltage" go across the capacitor in the radio circuit as described (see text), while the leads marked "To Controlled Circuit" go to the AC input of the simulator.

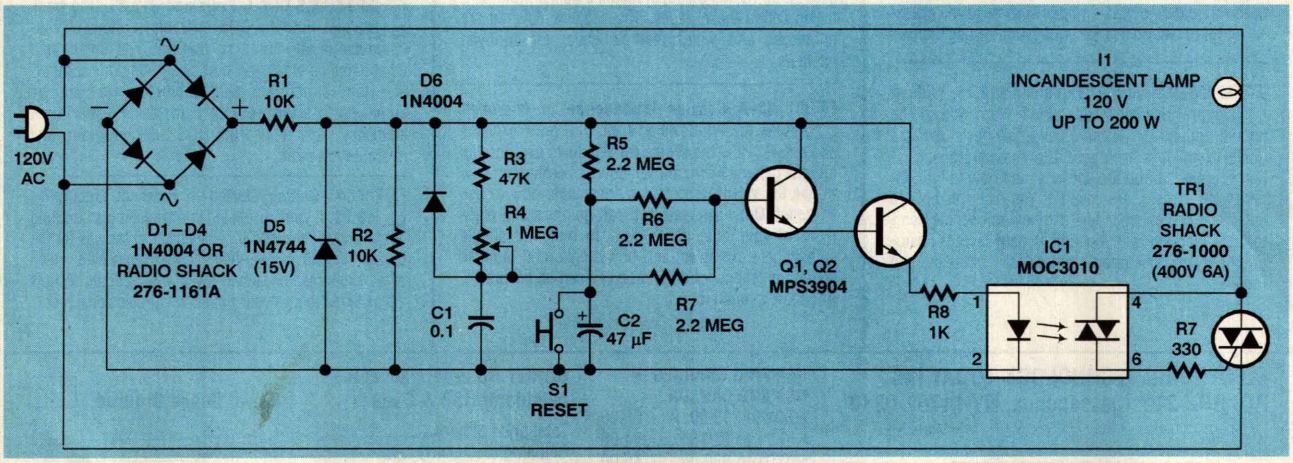

FIG.1—WHILE THE BEST APPROACH WOULD BE TO USE A MICROPROCESSOR, this all-analog circuit will fill the bill. It is a modernized version of a "dawn-simulator" circuit originally published by General Electric.

You can use any Triac with suitable ratings. For D1–D4, you can use four 1N4004s or one bridge rectifier (Radio Shack 276-1161A or similar). Check the temperature of the Triac and of R7 while the circuit is operating (but beware of high voltage); use a heat sink on the Triac and/or a higher-wattage resistor (as appropriate) if they get hot.

A word of caution: This circuit can generate appreciable radio-frequency interference (RFI). Keep the light bulb close to TR1, and if you have RFI problems, put a 100-millihenry RF choke in series with the Triac and light bulb.

Now for the clock-radio interface. What you'll need to do is find a DC supply voltage inside the radio that is switched by the electronic clock circuit. That will probably be between 6 and 12 volts; look for it across a large electrolytic capacitor near the radio circuitry. Some exploration with a voltmeter will be required. Once you've found a switched voltage source, connect it to a solid-state relay as shown in Fig. 2. You can then use it to control 120-volt AC loads.

Changing Voltage

Q *We have a Sony AM/FM clock radio that runs on 120-volts AC, 60 Hz. How could we use this on 220 volts, 60 Hz, outside the United States? What kind of dropping resistance could be incorporated into the circuit? We tried a line-voltage converter from Radio Shack, but it didn't work. — G. J. S., Newhall, CA*

A If the foreign AC power is actually 220-240 volts, 60 Hz (not 50 Hz), all you need is a transformer. A voltage-dropping resistor wouldn't be satisfactory because the voltage drop depends on the amount of current being drawn through it, which depends on how loud the radio is playing, among other things.

Radio Shack's 273-1401 voltage converter or any comparable transformer should do the job. This kind of voltage converter is relatively heavy because of its iron core and is rated to handle only 50 watts or so. Don't use the other kind of converter, which is lightweight and handles hundreds of watts; it doesn't produce normal AC output. Instead, it trims away part of the AC waveform like a light dimmer (see "Dawn Simulator" elsewhere in this column) and is suitable only for lights, heating elements, and some types of motors.

Also, double-check that the foreign power is 60 Hz, not 50 Hz. British and European power is 220 to 240 volts, 50 Hz, and transformers change the voltage but not the frequency. Also, check the label on the radio; if it says "50-60 Hz" then both frequencies are OK. Otherwise, there is no cheap way to change the frequency of the AC power; it's cheaper to get another radio.

Bulk Tape Eraser

Q *I want to build an electromagnet to erase VCR tapes. Low-priced bulk erasers mostly just muddy the tape and you have to take a nap between erasures to let the magnet cool. A commercial unit that develops 3000 Gauss costs over $350, but I can't afford that investment. I could wind my own magnet if I had the specifications. — R. C., Meridian, MS*

A Before giving up on low-priced bulk erasers, make sure you're using them as effectively as possible. The tape has to get very close to the magnet in order to be erased. Consult the instructions to find out how to position the eraser and the tape. Erasing a tape should take only a few seconds and should not overheat the magnet. After erasing, be sure to move the magnet well away from the tape before turning it off to avoid re-magnetizing it with the pulse that occurs at turn-off.

Next, experiment. Could you combine two cheap erasers to make a more effective one? Another cheap way to get strong electromagnets is to take apart junked electric motors. We once made a small, effective demagnetizer by removing the rotor from a phonograph motor; perhaps you could do the same thing with a larger induction motor to make a tape eraser. Be sure to include a light bulb in series with the electromagnet in order to limit the current; you can get more current by changing to a higher-wattage bulb.

Powering Probescope From Computer

Q *I use a RadioShack Probescope, which is a hand-held digital oscilloscope that inter-*

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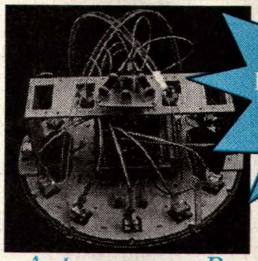

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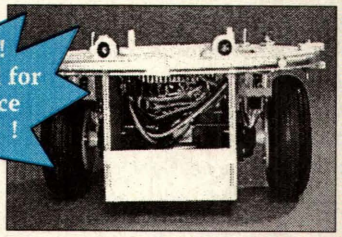

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To discuss electronics with your fellow enthusiasts, visit the newsgroups sci.electronics.repair, sci.electronics.components, sci.electronics.design, and rec.radio.amateur.homebrew. "For sale" messages are permitted only in rec.radio.swap and misc.industry.electronics.marketplace.

Many electronic component manufacturers have Web pages; see the directory at http://www.hitex.com/chipdir/, or try addresses such as http://www.ti.com and http://www.motorola.com (substituting any company's name or abbreviation as appropriate). Many IC data sheets can be viewed online. Extensive information about how to repair consumer electronic devices and computers can be found at www.repairfaq.org.

Books: Several good introductory electronics books are available at RadioShack, including one on building power supplies.

An excellent general electronics textbook is *The Art of Electronics*, by Paul Horowitz and Winfield Hill, available from the publisher (Cambridge University Press, 1-800-872-7423) or on special order through any bookstore. Its 1125 pages are full of information on how to build working circuits, with a minimum of mathematics.

Also indispensable is *The ARRL Handbook for Radio Amateurs*, comprising 1000 pages of theory, radio circuits, and ready-to-build projects, available from the American Radio Relay League, Newington, CT 06111, and from ham-radio equipment dealers.

Copies of past articles: Copies of past articles in **Electronics Now** and **Popular Electronics** (post 1993 only) are available from our Claggk, Inc., Reprint Department, P.O Box 4099, Farmingdale, NY 11735; Tel: 516-293-3751.

Electronics Now and many other magazines are indexed in the *Reader's Guide to Periodical Literature,* available at your public library. Copies of articles in other magazines can be obtained through your public library's interlibrary loan service; expect to pay about 30 cents a page.

Service manuals: Manuals for radios, TVs, VCRs, audio equipment, and some computers are available from Howard W. Sams & Co., Indianapolis, IN 46214 (1-800-428-7267). The free Sams catalog also lists addresses of manufacturers and parts dealers. Even if an item isn't listed in the catalog, it pays to call Sams; they may have a schematic on file which they can copy for you.

Manuals for older test equipment and ham radio gear are available from Hi Manuals, PO Box 802, Council Bluffs, IA 51502, and Manuals Plus, PO Box 549, Tooele, UT 84074.

Replacement semiconductors: Replacement transistors, ICs, and other semiconductors, marketed by Philips ECG, NTE, and Thomson (SK), are available through most parts dealers (including RadioShack on special order). The ECG, NTE, and SK lines contain a few hundred parts that substitute for many thousands of others; a directory (supplied as a large book and on diskette) tells you which one to use. NTE numbers usually match ECG; SK numbers are different.

Remember that the "2S" in a Japanese type number is usually omitted; a transistor marked D945 is actually a 2SD945.

Hamfests (swap meets) and local organizations: These can be located by writing to the American Radio Relay League , Newington, CT 06111; (http://www.arrl.org). A hamfest is an excellent place to pick up used test equipment, older parts, and other items at bargain prices, as well as to meet your fellow electronics enthusiasts—both amateur and professional.

faces with a personal computer. My only problem is how to power it. It requires 9 to 13 volts DC and draws 12 to 85 mA. Sometimes, but not always, I can obtain power from the circuit under test.

After seeing the Pager Decoder featured in the 1997 issue of ***Electronics Now****, I'm wondering if the Probescope can be powered from the computer's serial port in the same way that that project was. Is this practical? — G. O., Roseville, MN*

A Sadly, the answer is no. The data lines of a serial port can easily provide a few mA to drive a CMOS circuit or even a single LED, but 12 to 85 mA is more than they can deliver. You can, however, power the Probescope from the 12-volt (yellow and black) wires of an unused disk-drive power connector inside your PC. If you frequently use your PC for electronic experiments, you may want to rig up external connections to its power supply so you can borrow power for experimental circuits. Use 0.5-amp fuses for protection.

Calling Benchmarq . . .

Q *I have a Sears Craftsman cordless drill whose charger uses a Benchmarq BQ2004PN integrated circuit. Sears won't give me any information on this IC. I would think they would be interested in selling the parts for their tools or helping me find them. Can anyone tell me how to find this part or a substitute? — J. W. B., Greenfield, OH*

A The drill is almost certainly made, or at least designed, for Sears by another company, and Sears probably handles the entire charger as a single replacement part.

However, the IC maker, Benchmarq Microelectronics, is easy to locate. Benchmarq makes a variety of high-performance battery-charger ICs. You can write to them at 17919 Waterview Parkway, Dallas, TX 75252, and request a data sheet, or see product data on the Web at www.benchmarq.com.

Benchmarq chips are sold by distributors; one of them is Marshall Electronics, 89320 Telstar Avenue, El Monte, CA 91731; Web: www.marshall.com; Tel: 800-833-9910. Marshall takes orders 24 hours a day.

Looking for MM5369

Q *In your January 1998 issue you recommended a National Semiconductor MM5368 or MM5369 IC for use in a precision pulse generator. Since the summer of 1997, National Semiconductor no longer makes these chips, and I haven't been able to find any equivalents. Do you know of any alternatives or any way of building an equivalent circuit from other chips? — A. H., Mountain View, CA*

A These chips generate precise 60-Hz squarewaves from, respectively, a 32.768-kHz watch crystal and a 3.58-MHz color TV crystal. The MM5368 is admittedly a rare beast, but it will be a while before the MM5369AA/N disappears from the hobbyist market. As this is written, it is still in stock at Jameco, 1355 Shoreway Road, Belmont, CA 94002; Web: www.jameco.com Tel: 800-831-4242 (where it is listed as "part no. 26104") and at Advanced Computer Products, 1310 E. Edinger Ave., Santa

Ana, CA 92705; Tel: 714-558-8822. You can get it in larger quantities ($100 minimum) from Ambassador Components, 1747-6 Veterans Hwy., Islandia, NY 11722; e-mail: sales@ambass.com; Tel: 516-234-5299.

A more modern solution to the same problem would be to program a microcontroller to produce a squarewave at the desired frequency. The new 8-pin PIC microcontrollers (PIC12C508 and PIC12C509) are especially compact and convenient. Or use a CD4060 14-stage binary counter chip, which includes gates that can be used as an on-board crystal oscillator, with a 0.983040-MHz crystal to generate 60 Hz. See the CD4060 data sheet (available online at www.nsc.com) for a suggested circuit. You can get that crystal custom-made for about $30 by International Crystal Mfg., 10 N. Lee Avenue, Oklahoma City, OK 73126; Tel: 800-725-1426, and while you wait for it to arrive, you can use a cheap 1-MHz microprocessor crystal for testing; that will give you 61.035 Hz.

Clock That Sets Itself

Q *I have seen digital clocks advertised that receive time signals from the National Institute of Standards and Technology and will keep the correct time automatically. I have been trying to find a schematic for such a clock without success. Do you know where I can obtain one? — L. J., Florissant, MO*

A You can still get a manual for the now-discontinued Heathkit "Most Accurate Clock" (model GC-1000-H) from Heath Company, Tel: 616-925-5899 (they sell manuals only by phone). Bear in mind that any clock of this type contains a programmed microcontroller that the schematic will not enable you to duplicate. More modern clocks that tune in NIST signals are available from Comtrad Industries, 2820 Waterford Lake Drive, Suite 102, Midlothian, VA 23113; Tel: 800-992-2966.

The NIST signals are delivered by shortwave radio from stations WWV, in Colorado, and WWVH, in Hawaii. Reception varies quite a bit from place to place, and nowadays most people who need accurate time signals prefer to use a GPS satellite receiver. GPS receivers display the time of day and can be interfaced directly to computers as described in this column (see January 1998, pp. 11-12). Because a GPS receiver contains several very specialized ICs and works at ultra-high frequencies, it's not practical to build your own; instead, treat the entire receiver as a unit that can be interfaced to other projects.

Two Stereo Questions

Q *I am repairing a Sansui QRX-3300 4-channel stereo. I need a schematic and service manual. Where can I get them? I would be willing to pay a fair sum.*

Also, now that stereos have remote controls, why doesn't the remote control include a speaker A/B switch? Is there a simple way to add one? — R. S. N., Marathon, FL

A Your best and most likely source would be the manufacturer, Sansui Electronics, 17150 S. Margay Avenue, Carson, CA 90746; Tel: 310-604-7600.

As for your second question, remote controls normally switch the low-level signals at the input of the amplifier. This switching is done with CMOS digital and analog ICs. A speaker A/B switch switches the output of the amplifier at the speaker connections; that's a high-level signal and no additional resistance is tolerable (obviously, even 1 extra ohm would affect the output from a 4-ohm speaker). For this reason, an A/B switch has to be mechanical or electromechanical. If you wanted to add one, you'd have to use relays, which cost more money and take up considerably more space than ICs.

Writing to Q&A

As always, we welcome your questions. The most interesting ones are answered in print. Please be sure to include plenty of background information (we'll shorten your letter for publication) and give your full name and address. *If you are asking about a circuit, please include a complete diagram.* Write to "Q&A," **Electronics Now** Magazine, 500 Bi-County Blvd., Farmingdale, NY 11735. Due to the volume of mail, we regret that we cannot give personal replies. EN

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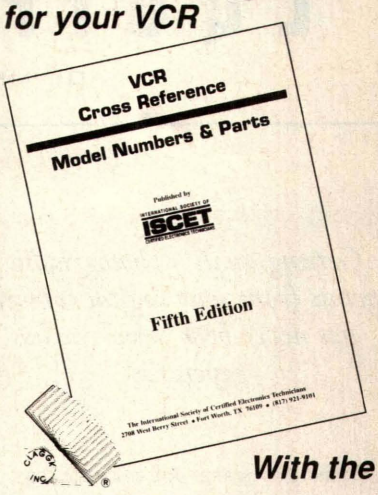

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EQUIPMENT REPORT

OLYMPUS P-300 PERSONAL PHOTO PRINTER

Getting quality photographic prints from your digital camera has never been easier, or less expensive.

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Until recently, digital photography has always been a promising technology, but one that was full of compromises. For one thing, the digital cameras themselves have been quite expensive, and the only ones that were even close to being affordable for the casual user offered relatively low resolutions—usually a maximum of 640 × 480.

But that is changing. Cameras having resolutions of 1024 × 768 and higher are now available at prices of around $600, and sometimes lower. And while they still do not quite measure up to well-focused photographs made with conventional film, images with a resolution of 1024 × 768 can be made into photo-album size prints that look incredibly sharp.

Which brings us to another problem with digital photography: producing paper prints from electronic images. Let's face it: most people still keep their favorite photos in albums and don't want to have to turn on a computer to see them. There are services that will take the output from your camera and produce finished prints, but most are not inexpensive, and it can take a while to get your prints back. Plus, most require that you have online access of some sort to upload the digital images to them.

More popular is using an ink-jet printer to produce prints, but there are problems here, too. For one, only some ink jets are capable of producing prints of acceptable quality. And even those usually require the use of special "photo" ink cartridges and paper for best results. Further, both the paper and the ink are relatively pricey, and printing photos uses a lot of ink and can take a long time to do.

Now, however, there's a better alternative. It's a neat little printer from Olympus whose output rivals 35-millimeter prints, and it is much better than the photos produced by instant cameras.

Olympus P-300

The P-300 is a 300 dpi, photo-quality dye-sublimation printer that produces continuous color tones. The P-300's output is equivalent to that of a 2400-dpi ink-jet printer. Images are printed on 4- by 5.5-inch glossy sheets in true 24-bit color (16.7 million possible colors). It takes about 100 seconds to make a print. Images can come from scanners, digital cameras, the Internet, and so on—as long as they're digital, you can print them on the P-300.

Olympus has equipped the P-300 with a parallel port for connecting to PCs and a serial Macintosh port for connecting to Macs. You'll need at least a 486 PC running Windows 3.1x or Windows 95, or a Mac with a 68040 PCU or later and Mac OS 7x or later. A CD-ROM drive is also required. You can use whatever software you like, such as Adobe Photoshop, to print to the P-300. You simply have to set the print size to that of the P-300's paper.

And if you happen to have an Olympus digital camera, you don't even need a computer to create prints. Though the procedure differs slightly from camera to camera, any Olympus digital camera can be connected directly to the printer and prints can be made right from it. The P-300 will not work directly with digital cameras from other manufacturers.

The P-300 measures $10^{7}/_{8}$ inches front to back with its tiny paper tray attached and is $2^{5}/_{8}$ high by $9^{5}/_{8}$ inches wide. It weighs 5 pounds 8 ounces. It prints 3.5- × 4.5-inch images on 4- × 5.5-inch sheets. The paper tray holds 30 sheets, and a thumb wheel on the tray lets you set the number of prints you want of the same image.

The P-300 requires a special dye-sublimation ribbon that looks like cellophane reeled up in a film cartridge. The ribbon cartridge, good for 60 prints, slides into the side of the printer. The printer uses heat to fuse color from the ribbon onto the print sheets in continuous tones.

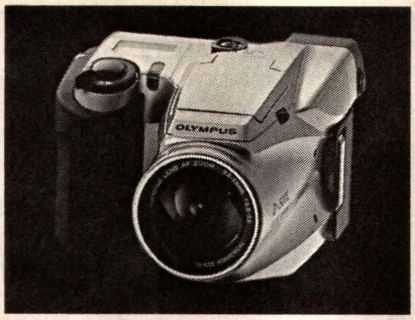
Aside from the 4- × 5.5-inch glossy photo paper, Olympus also offers sticker-label photo paper and miniature sticker-photo labels, 16 to a sheet, which are great for sealing envelopes and the like.

Hooking It Up

The P-300 was tested both connected to a PC and connected directly to an Olympus camera. The printer is easy to unpack from its carton because of its small size. There is very little to set up: You simply insert the paper tray into the front of the printer, load the glossy photo paper and ribbon cartridge, plug the printer into an outlet, and you're off.

Connecting the P-300 to a PC is easy. You simply connect it with a parallel cable and load the drivers using the "Add New Printer" icon in the Windows control panel. Then use whatever graphics program you have available. One benefit to using a computer is that images can be retouched and enhanced before printing, which, of course, is not possible when printing directly from a camera.

The perfect complement to the P-300 printer is the Olympus D-500L



THE OLYMPUS D-500L digital camera is the perfect companion to the P-300 photo printer. The printer can also print directly from any other Olympus digital camera, or from any digital camera if a computer is used.

Digital Camera. It has a maximum resolution of 1024 × 768, a 3× zoom, a back panel color LCD for reviewing images, three levels of compression, a serial port for connecting to computers, and a parallel port for connecting directly to the P-300 printer.

A special cable connects the D-500L camera to the P-300 printer. After the two units are connected to each other they can be turned on. With the camera set to play back its stored images, they can be previewed on the screen on the back of the camera. Whichever image is displayed on the camera can be printed at the touch of a print button on the D-500L camera. With some other Olympus digital cameras, a "Direct Print" button on the P-300 is used, though it has no function when the printer is connected to the D-500L. Once the print button (on either the camera or the printer, depending on the setup) is pressed, the printer starts whirring and about a minute and a half later, a glossy color print pops out. Multiple prints can be made by setting a dial on the side of the paper tray.

The P-300 costs $399, and it comes with a 10-print paper and ribbon kit. Additional 60-print paper/ribbon kits sell for $39.95, and are available wherever the printer is sold. The D-500L has a suggested retail price of $799, though there are much less expensive Olympus cameras that will print to the P-300 (and don't forget that the unit will work with just about any digital camera). For more information on the P-300, contact the manufacturer directly (Olympus America Inc., Digital & Imaging Systems Group, Two Corporate Center Dr., Melville, NY 11747; Tel: 800-347-4027; Web: www.olympus.com), or circle 15 on the Free Information Card. EN

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BY JEFF HOLTZMAN
COMPUTER EDITOR

XML Update, C++ Builder, and More

I GAVE A PRETTY TIGHT OVERVIEW OF XML LAST MONTH, AND DIDN'T PROVIDE ANY REFERENCES FOR FURTHER STUDY. I'LL TRY TO CORRECT THAT DEFICIENCY NOW; IN ADDITION, I'VE SINCE RUN ACROSS A FEW MORE RESOURCES THAT CAN HELP flesh out the details.

The canonical source is the XML spec (Extensible Markup Language (XML) 1.0, W3C Recommendation 10-February-1998), available at the World Wide Web Consortium www.w3.org. Counting appendices, the spec is only 32 pages long. An easy read, right? Guess again. Without a good background in formal language theory, it will probably seem like Greek. Even with a good background, it's difficult, lacking in examples, and inconsistent in treatment depth across various areas.

There are several FAQ documents floating around. The best is "The XML FAQ," available at www.ucc.ie/xml/. Microsoft, ArborText, and other interested commercial concerns have their own FAQs that tend to be interesting as indicators of how the companies interpret and plan to extend XML. For example, Microsoft's FAQ discusses the concept of schemas; quoting directly from the 1/8/98 document (the word schema appears nowhere in the 2/10/98 W3C Recommendation):

"Schemas combine concepts from DTDs, relational databases, and object-oriented design. Schemas can describe the structure of XML documents, databases, directed-labeled-graphs, and other similar organizations of data. Schemas supply additional semantic information to documents, and contain new facilities such as data types, inheritance, and extensibility that are not available in DTDs. Schemas use the same syntax as XML documents."

Microsoft's FAQ also briefly mentions Channel Definition Format (CDF), the company's XML-based "push" technology that provides a way for web servers to deliver advertising and other goodies to your browser; Open Software Description (OSD), an XML format to aid software distribution; Open Financial Exchange (OFX), a format for communicating with financial institutions; and Resource Description Format (RDF), which (to quote again) *"allows for generalized searching of information without application-specific rules... [and] ... allows a complementary view of data through graphs and nodes, rather than through a structured tree, which the current XML technology enables."*

Of all the technologies mentioned in the previous paragraph, RDF sounds most interesting to me, with its hint of a hyperlink modeling scheme. I wouldn't be surprised to see RDF end up as the core of the Windows Help System someday. The Schema concept is also tantalizing.

RESOURCES

Using HTML 4
Lois Patterson, *et al.*
Que 1998
ISBN: 0-7897-1450-7

Presenting XML
Richard Light
Sams1997
ISBN: 1-57521-334-6

XML Books

Chapter 16 of *Using HTML 4* contains a pretty good overview of XML, along with a few very basic yet practical examples. I wouldn't buy the book just for that chapter, but if you do any web development, it would be a reasonable investment.

The most detailed, in-depth treatment I've found so far is *Presenting XML*, by Richard Light. One thing I don't like about the book is Light's frequently sloppy language. To me it seems unforgivable that a book about a formal language is so careless in its description of that language. It's great to try to avoid being terse (like the spec) or pedantic, but the cure seems worse than the disease in this case.

Anyway, if you read carefully and cross-reference the spec, you can learn a lot from *Presenting XML*. The spec itself is well dissected. There are lots of examples, including a chapter on converting HTML to XML, another on available XML software, and a good bibliography.

C++ Builder 3.0

In today's business world, can you create documents or spreadsheets in anything but a Microsoft product? That's debatable. But there's no question that you can create programs without supporting the MS habit. A few years ago, lots of naysayers predicted Borland's imminent decline; in case you haven't noticed, Borland is back, and with a vengeance.

Recent publicity from the company trumpets four consecutive quarters of revenue growth and three of profitability. The last three product introductions

(Continued on page 25)

Prototype

The National Lightning Detection Network

Whether it involves building new electric-power distribution lines, forecasting weather, planning military-training exercises, or establishing responsibility for damage, detailed information on lightning-strike activity can be important. That information—both real time and historical—is now readily available thanks to the National Lightning Detection Network (NLDN). The NLDN, owned and operated by Global Atmospherics, Inc. (GAI) in Tucson, AZ, is the largest and most sophisticated lightning-detection and -location system in the world.

The NLDN consists of ground-based sensing stations that detect cloud-to-ground lightning activity across the continental U.S. The sensors instantaneously detect the electromagnetic signal given off when lightning strikes the ground. Sophisticated techniques are used to differentiate between lightning strikes and background noise. The individual sensors transmit the lightning data via a communications satellite to central ground stations. These, in turn, send the information to the Network Control Center (NCC) in Tucson.

Using data from two or more sensors, computers at the NCC determine the strike location to within an average accuracy of 500 meters (1640 feet). That high level of accuracy is achieved by a combination of waveform processing, Global Positioning System (GPS) time synchronization, high-speed signal processing, and wide-band peak-gated magnetic direction-finding techniques. Processed lightning strike data is sent to subscribers' computer displays via satellite normally within 15-20 seconds of the actual lightning strike. Besides location, the time, polarity, and amplitude of each strike is transmitted to the recipient.

LIGHTNING STRIKES CAN BE BEAUTIFUL, but they can also be expensive, dangerous, and even deadly.

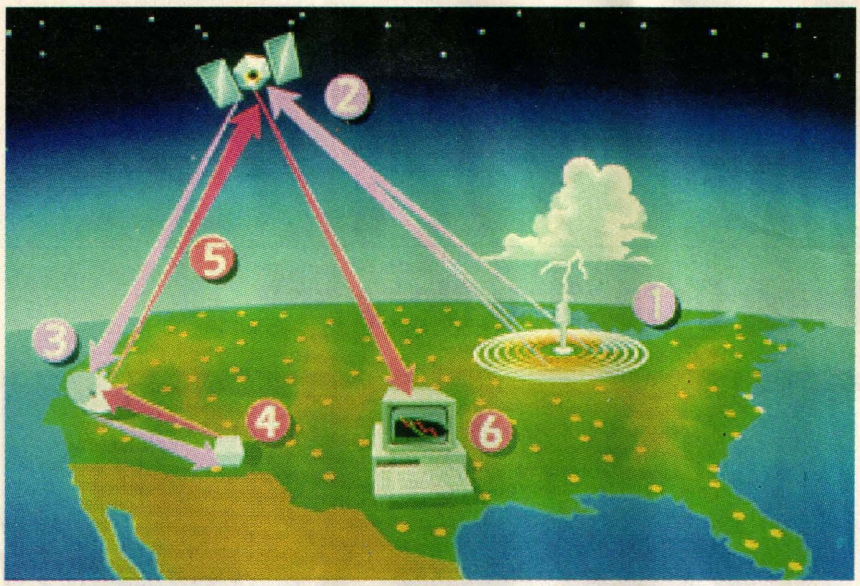
A Growing System

The NLDN provides real time information about lightning strikes as well as a historical archive data library containing over 160 million flashes from 1989 to the present. The NLDN is the result of over twenty years of research and development first initiated by the Electric Power Research Institute (EPRI), the research arm of the electric power industry. The original objective was a system to help utilities make decisions about line-maintenance priorities, effective crew dispatch, and future design and placement of utility lines to reduce lightning damage and to make faster repairs should lightning strike. The NLDN was originally developed by the State University of New York at Albany in cooperation with the Bureau of Land Management and the National Severe Storms laboratory. The final implementation of the technology was developed by GAI.

The system is undergoing a dramatic expansion, and will soon be known as the North American Lightning Detection Network (NALDN). That's because Environment Canada's Atmospheric Environment Service has contracted with GAI for a companion Canadian Lightning Detection Network (CLDN) that will be integrated with the NLDN. When completed, the NALDN will cover the North American land mass south of 60 degrees North Latitude to the northern border of Mexico, and extend from the Pacific to the Atlantic Oceans. The combined system will include 105 ground-based sensors in the U.S. and 81 other sensors in Canada.

Users and Applications

Users of the NLDN's real-time and historical lightning data include the National Weather Service, NASA, the FAA, and the military. The data is of



HOW THE NLDN WORKS: 1. Sensors transmit data to satellite; 2. Satellite relays information to earth station; 3. Data is transmitted to NCC via land-lines; 4. NCC processes data; 5. Processed data is relayed back to satellite; and 6. Lightning data is displayed within seconds of an occurrence.

value for power-quality assurance, aviation, forensic analysis, personnel and equipment protection, mining, insurance-claim investigation, meteorology, and many other applications. For example, historical data is provided to the insurance industry for lightning damage and claims verification. Being able to verify the existence or absence of time-coincident lightning in the vicinity of a policyholder's claim for lightning-caused property damage reduces the cost of investigating claims. Likewise, utilities can use NLDN data in resolving warranty claims. When suppliers deny a claim because they say the damage was caused by an "act of God", archival data can show there was no lightning activity when the piece of equipment went down.

GAI provides a wide variety of NLDN products, and each can be tailored to meet the needs of individual subscribers. For instance, THUNDER is a software package that operates with a real-time link to the NLDN via either a satellite downlink or modem connection. THUNDER's dual-monitor, display package provides uninterrupted viewing and tracking of lightning events in a particular region as they occur.

The Fault Analysis and Lightning Location System (FALLS) was specifically designed to address the Electric Power industry's lightning concerns. FALLS, with its various modules and reports, allows complete, in-depth analysis of lightning and its cause and effect on, and association with, power delivery-system reliability. FALLS can be used to assess lightning-exposure risk for power lines, telecommunication lines, railways, gas pipelines, forested areas, or even single customer facilities.

FAULTFINDER is another product that can determine whether lightning strikes played a role in an outrage or momentary interruption. It can eliminate the problem of erroneously categorizing unverified outages as lightning-related, ignoring the possibility of equipment malfunction, improper grounding, wind and other factors that affect system reliability.—BILL SIURU PT

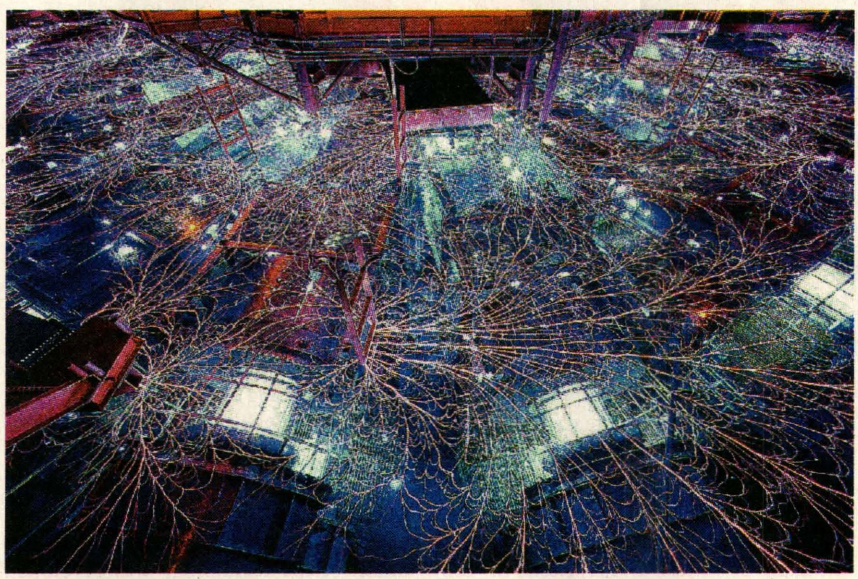
FOR MORE INFORMATION

Global Atmospherics, Inc.
2705 E. Medina Road
Tucson, AZ 85706-7155
Tel: 520-806-7300; Fax: 520-741-2848
Web: www.glatmos.com

Accelerator Takes A Giant Step Towards Fusion

Sandia's Z accelerator—the most powerful producer of x-rays in the world—has recently produced another world record for power output, making it a viable contender in the quest to achieve sustainable nuclear fusion. The most recent increase—bringing its output to 290 trillion watts (terrawatts)—shatters by nearly 40 percent its previous world record set last summer.

The Z machine works by firing massive bursts of electricity to superheat a miniature oven, a hohlraum, which is about the size of a sugar cube. The electrical energy fired at the target is the equivalent of 60 times the world's usage of electrical power at a given moment.



SANDIA'S Z ACCELERATOR is the world's most powerful x-ray machine.

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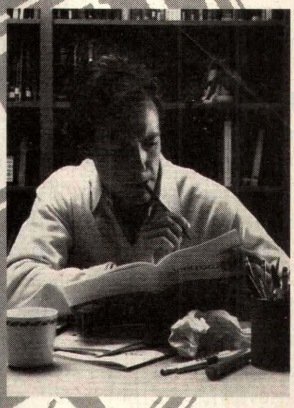

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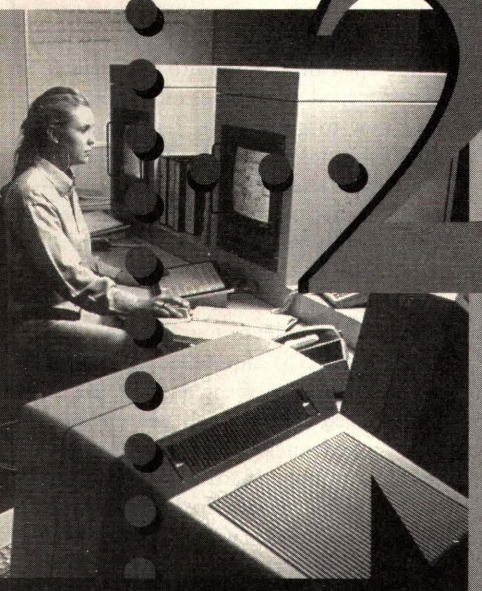

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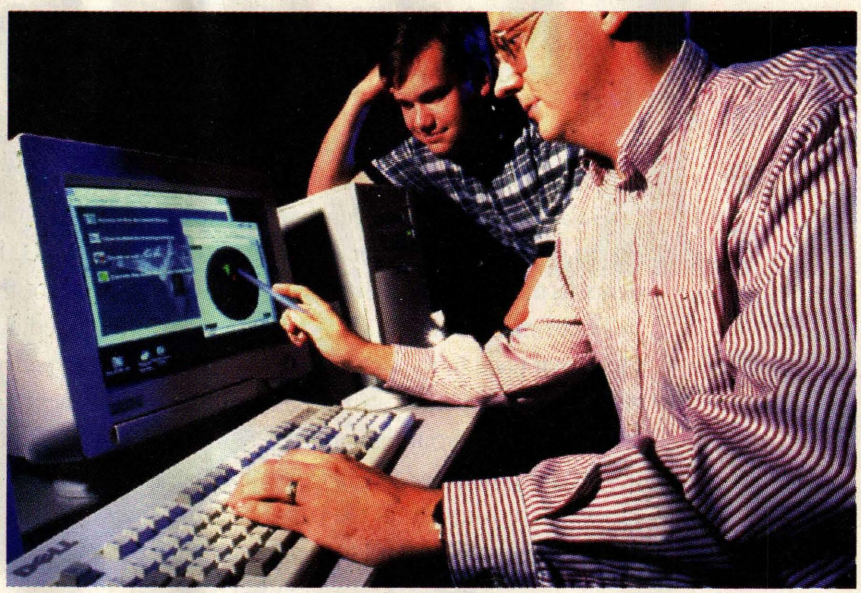
Lasting only a fraction of a second, the shot generates temperatures greater than 1 million degrees, ever closer to the 2 to 3 million degrees required for nuclear fusion. Temperature is particularly important in the quest for fusion, in which much more energy is created than used.

In the past 18 months, the Z machine has increased its output by more than seven times, starting from 40 terrawatts. Before that, it took 25 years for a succession of Sandia accelerators to reach the 40-terrawatt level. Each successive test has helped lay the groundwork for sustainable nuclear fusion. It also has provided data to help test U.S. nuclear defenses without physically exploding large-scale devices. PT



RESEARCHERS BRIAN KEETON AND WILL NELSON at the GTRI at interactive how-to guide called the Test Engineer's Workstation *(TEWS)*.

Ultrasound Improves Truck Tire Safety

At the University of Illinois at Urbana/Champagne (UIUC), a fast, low-cost inspection system has been developed for evaluating the structural integrity of new and used steel-belted radial truck tires. Using ultrasonic sound waves, the instrument detects ply delaminations; weakened, damaged, or broken cords; and other, potentially dangerous, hidden defects. Professor of General Engineering Henrique Reis and graduate student Paul Golko use an analytical, nondestructive evaluation technique called acousto-ultrasonics to check for hidden damage.

The first step is to inject a sound wave into the side of the tire, using an ultrasonic transducer. The ultrasonic pulse then propagates along the sidewall, where it is picked up by another transducer and analyzed by a computer.

"Tires are scanned with measurements recorded every 0.3 degree of tire rotation, for a total of 1200 samples," Reis said. "This angular sampling interval was chosen because it is smaller than the spacing between radial cords on the tire at the transducer locations. Therefore, we can test for damage in each individual cord. The entire measurement takes less than a minute per tire."

By studying the attenuation characteristics of the transmitted signals, the researchers can analyze damage within the tire. "We can detect strained or damaged cords because the sound wave is not transmitted as efficiently as in a normal steel cord," Reis said. "The greater the damage, the higher the signal attenuation. If the signal disappears, the cord is broken. By studying the signals, we can also detect areas where the steel cords and rubber have separated."

A color-coded display is used to graphically represent the results. It shows not only regions of broken or damaged cords, but also areas where the steel cords are weakened to the point where the tire should be removed from service. By evaluating the residual strength in the sidewalls, the instrument can determine a tire's remaining useful life and whether it is worth retreading.

"For safety reasons, we don't want to use bad tires," Reis said. "But for ecological reasons, we don't want to throw away good tires that can be retreaded. This instrument enables us to easily distinguish between the two." PT

Test Engineer's Workstation

Technical manuals can be massive and intimidating, so researchers at Georgia Tech Research Institute (GTRI) came up with a solution to "manualitis." They turned a computer into an interactive how-to guide—the Test Engineer's Workstation (TEWS). The machine uses hypertext links and multimedia—graphics, video, and sound—to decrease the learning curve on complex test and evaluation jobs.

At the request of the U.S. Air Force, the GTRI's Electronic Systems Laboratory (ELYS) developed TEWS. It was designed to meet an ongoing Air Force need to bring new test engineers up to speed quickly in electronic-warfare systems testing. Hard-copy documents and word of mouth from people who had done it before were the only previously available resources. With TEWS, engineers can quickly find out what a piece of equipment does and what it did last time.

The GTRI developers distilled massive test manuals into on-screen programs that lead test engineers through evaluations of new and upgraded systems, helping them plan, conduct, and accurately analyze a test. In developing the TEWS platform, the team combined video and audio materials—from lectures to slides and video—onto CD-ROM discs that are accessed from Windows PCs. Users can click on any on-screen subject to view and listen to the requested information, and they can replay any segment they choose.

TEWS aids engineers in the analysis of test data through its ability to use the Automated Data Reduction Software (ADRS).The software computes performance and effectiveness measures to satisfy test-program requirements for electronic-warfare systems. Implemented as a Microsoft Windows application, ADRS helps ensure the quality of data collected and that the resulting analysis satisfies the test objectives. As important, TEWS helps developers design their own test plans from scratch. The program even has pop-up help boxes with questions that designers need to ask themselves.

Users can customize TEWS to fit their location and test-facility type. Since a video-capture card lets users add standard video input to existing test programs, this feature allows online information about defense systems to be added as they are tested.

"Maintaining good descriptions of results means that if, say, two years later you make another change and you have to retest, you don't have to start over," says Brian A. Keeton, an ELYS research engineer, who works in test process development. "You can compare it to the last test pretty easily."

Several TEWS systems have been installed at the Air Force Development Test Center at Elgin Air Force Base, the Air Force Flight Test Center at Edwards AFB, and at GTRI to support the defense-systems testing arena. The TEWS approach may have applications in other fields, where on-the-job training, system testing, and archiving of results need to be efficiently combined. PT

You're Never Too Old

For his upcoming 80th birthday on Sept. 22nd, NASA aeronautical engineer Seth Anderson plans to go gliding off Glacier Point again. This will be a replay of his 79th birthday celebration, when Anderson last glided from Glacier Point, more than 3200 feet above the valley floor at Yosemite National Park, CA. He soared on a breath-taking 16-minute hang-glider ride that he videotaped, as he always does.

His hang glider is a NASA spin-off from space research. "It was originally called a Rogallo Wing, for Francis Rogallo, who in the early 60s experimented at NASA's Langley Research Center, Hampton, VA, with a paraglider as a possible landing method for space capsules," said Anderson. "If it had been used for the two-person Gemini capsule, astronauts could have landed on terra firma instead of parachuting to water landings."

SETH ANDERSON hang gliding over Yosemite.

As a contemporary of Rogallo, Anderson knows his NASA history. He began his career at Ames Aeronautical Laboratory, Moffett Field, CA, in 1942. Today, Ames is a NASA research center, where Anderson studies human factors for the agency's Remotely Piloted Aircraft Program. Human factors engineers examine the interactions between human beings and aircraft.

To allow Yosemite visitors to see the park from a bird's-eye view, Anderson has decided to donate his hang-gliding video to Yosemite for playback in the visitor's center. Visitors will be able to see many scenic views of the valley from a unique vantage point.

Hang gliding, Anderson believes, is a spectacular recreational sport. "I started 17 years ago. But hang gliding is an unusual hobby, not for the timid." Anderson has also built an experimental BD-5 turboprop aircraft at his home that he now flies.

Of his planned birthday flight, he says "It'll really be exciting." PT

Aviation Accident Prevention Program

In cooperation with the FAA, NASA is developing an automated system called the Aviation Performance Measuring System at NASA's Ames Research Center (Moffett Field, CA) that could better prevent commercial aviation accidents. By reducing the human labor needed to process the large quantities of performance data received, this program enhances the data collection and cost effectiveness of safety procedures of U.S. carriers.

Aircraft systems that generate performance data are used to troubleshoot potential future aircraft problems. Monitoring over 1200 operational functions of the aircraft, the system provides valuable early warnings of potential problems in numerous areas, including performance, cockpit instrument inputs, electrical equipment, fuel, and hydraulics.

"This gives the airlines an eye on operations that they don't now have," said Linda Connell, director of FAA-NASA's Aviation Safety Reporting System, which complements the $3 million joint research program, funded by the FAA.

Alaska Airlines was the first carrier

to enter an agreement with NASA for collaboration on a suite of system's tools. United Airlines later signed a similar agreement. The system is undergoing operational testing by airline personnel, analyzing data from the first aircraft equipped with Quick Access Recorders.

Under NASA's new Aviation Safety Program, the system will eventually be extended to service the engineering, maintenance, and training needs of commercial airlines; as well as to commuter, cargo, and corporate air carriers. The system provides a prototype of a flight data analysis ground station with broad-based reporting capabilities customized to the needs and operations of U.S. airlines. It includes specific provisions for transfer of prototype products to commercial vendors using present safety programs and technology.

"By incorporating advanced automation techniques, we can detect accident precursors we didn't know existed," said Dr. Richard Keller, research leader for intelligent systems technology. "The carriers also can use the system proactively to forestall future problems by improving training, operations, and maintenance procedures," he added.

Tailless Fighter Flies High

The NASA/Boeing X-36 Tailless Fighter Agility Research Aircraft successfully completed its flight research program—demonstrating the feasibility of future tailless fighters achieving agility levels superior to today's best military fighter aircraft. The project goals are to develop technologies to improve the maneuverability of future fighter aircraft. "All of our project goals were met or exceeded," stated Mark Sumich, X-36 project manager at NASA's Ames Research Center, Moffett Field, CA.

During the final flight phase, the X-36 project team examined the aircraft's agility at low speed/high angles of attack and at high speed/low angles of attack. "We also achieved the final flight's goals to expand the X-36's speed envelope up to 206 knots (234 mph)," Sumich said.

Thirty-one flights were made during the six months of the flight research program at NASA's Dryden Flight Research Center, Edwards, CA. The X-36 flew a total of 15 hours and 38 minutes and used four different versions of flight control software. The aircraft reached an altitude of 20,200 feet and a maximum angle of attack of 40 degrees.

The 28-percent scale X-36, built by the Boeing Phantom Works in St. Louis, MO, is designed to fly without the traditional tail surfaces common on most aircraft. The X-36 is 18 feet long with a 10-foot wingspan; is three feet high; and weighs 1270 pounds. The aircraft is powered by a Williams Research F112 turbofan engine that provides 700 pounds of thrust. It is remotely controlled by a pilot in a ground station cockpit, complete with a heads-up display. The pilot-in-the-loop approach eliminates the need for expensive and complex autonomous flight-control systems.

The X-36 Flight Test program team was comprised of employees from Boeing, Ames, and Dryden. Beginning in 1989, Ames and the Boeing Phantom Works developed the technologies required for a tailless fighter—a project that was jointly funded under a roughly 50/50 cost-sharing arrangement. To develop, fabricate, and flight test the two prototype aircraft cost approximately $20 million.

With the flight-test program completed, the X-36 will be placed in flyable storage condition in a hangar at Dryden. "Discussions are underway about what to do next with both of the X-36 aircraft," said Gary Cosentino, X-36 deputy project manager at Ames. "There is a potential for other technologies, such as a highly advanced reconfigurable flight control system, to be incorporated on the aircraft and possibly flight tested in the future." PT

Intelligent Machines Inch Forward

Representatives of Sandia and the Department of Energy (DOE) met recently to begin developing a road map for the future of the United States' robotics and intelligent machine industries. Also attending were representatives of other agencies, including the Department of Defense, the Department of Commerce, NASA, and the National Science Foundation.

The meeting was a result of Sandia's long-standing efforts to establish a national robotics and intelligent machines initiative based on America's technical excellence in sensors, software, controls, and computers—elements that turn simple robots into intelligent machines. An earlier milestone in this effort was the National Needs Workshop on Robotics in Albuquerque, NM. Robotics experts from around the country attended this workshop, which led to a day-long Congressional Expo on Intelligent Machines that was held on Capitol Hill.

Speakers at the Expo stressed that the United States has the opportunity to become a global leader in the robotics and intelligent machines industry. But government, academia, and industry must act quickly to achieve a leadership position, they said.

Sen. Jeff Bingamin, of New Mexico outlined his national action plan during a keynote address at the Expo, recommending that DOE and NASA establish three test-bed centers for robotics and intelligent machines at Sandia, Carnegie Mellon University, and the Jet Propulsion Laboratory that would be open to other federal agencies and private-sector researchers. The centers would provide prototyping capability for potential users, serve as meeting grounds for researchers from different disciplines, develop and disseminate generic software for robots, and establish training courses for young professionals.

During the Expo, Sen. Pete Domenici, New Mexico's senior senator, also stated his support of the plan. In his speech, Domenici said the robotics industry is poised to quickly rival the enormous and ever-expanding telecommunications industry. He added that Sandia is a logical location for a national test bed where government, industry, and academia can work together on research and development to commercialize new robotics and intelligent machine-products.

The Expo prompted a bipartisan Senate-House task force to endorse Bingamin's plan to establish the national initiative for intelligent machines and to request the recent meeting of high-level representatives. PT

COMPUTER CONNECTIONS

continued from page 16

have been none too shabby either. I'm referring to Delphi 3.0, JBuilder 2.0, and C++ Builder 3.0 (CB3 for short).

I still do more development in Delphi than any other environment, and it kicks. However, CB3 is highly attractive and may finally force me to switch. It takes the best Delphi has to offer (the development environment and the VCL), throws in several major enhancements, and numerous C/C++ specific features.

As with Delphi, but even more so, you can use CB3 for both application and systems development. At the application level you have your choice of three major Windows-class libraries: MFC, OWL, and VCL. MFC, of course, is the Microsoft Foundation Classes; CB3 supports version 4.2. OWL is Borland's Object Windows Library, at one time a competitor to MFC, but no longer. I guess there are still some people using it in a legacy mode. VCL is the Visual Component Library from Delphi.

On-screen, CB3 looks almost exactly like Delphi. In fact, the visual-development components (buttons, forms, etc.) are the Delphi components. You can install Delphi-developed components directly into CB3; unfortunately, the converse is not possible. Nonetheless there is still a high degree of compatibility and interoperability between the two.

Borland has discontinued Borland C++; CB3 is the company's C/C++ compiler from this point forward. There is no 16-bit support. CB3 has an excellent new project manager, DLL and EXE debugging, and fully supports the recent ANSI C++ standard, including the Standard Template Library (STL), and more.

Bottom line: If you're a C++ developer on Wintel, you owe it to yourself to take a close, hard look at CB3.

Java Notes

You may have heard about HP's introduction of a Java dialect. The anti-Java crowd instantly took this as a sign of technology fragmentation, a loss for Sun, and a win for Microsoft. I'm not so sure. HP's announcement, one might suspect, concerns a version of the language targeted for embedded use-in laser and ink-jet printers. Clearly, there is some bad blood between Sun and HP over this, but it seems to be more a sign of Sun's stretching itself too thin than anything.

Clearly, though, fragmentation is occurring. *PC Magazine's* special issue on Java (5/7/98) reported (for the second year in a row) that Microsoft's Java Virtual Machine (JVM) is faster and more compatible with the specs than all others, including Sun's. Meanwhile, Microsoft has been forced to stop using the Java logo because of its proprietary extensions to the language. Odd, no?

Sun wants to control the standard, but nasty HP and nasty Microsoft won't let it. Why is that? Why does no one complain about Microsoft holding the Basic standard, or for that matter HP the PCL (Printer Control Language) standard? Those are all *de facto* standards, not governed by any standards body, but owned and strictly controlled by single companies.

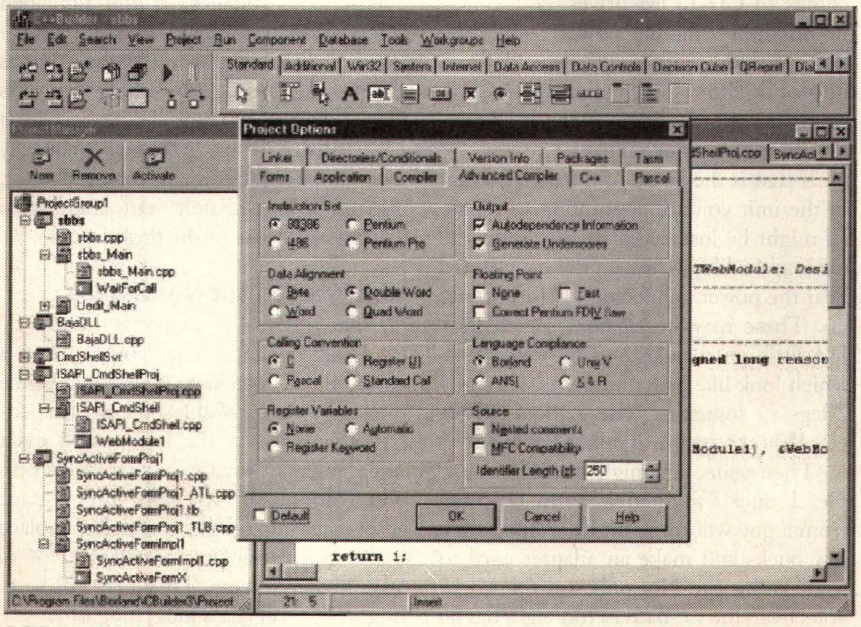
There are several million programmers using proprietary, single-sourced Visual Basic to produce real software that real people use in real companies every day. By contrast, Java is off by an order of magnitude or two in the number of developers, and by many orders of magnitudes in the number of actually running applications. So why the big fight over Java, and no fight over VB?

Let's all demand that HP go public with PCL! (That's a joke. I'd rather see Adobe go public with PostScript).

Meanwhile, Borland's JBuilder keeps racking up kudos; it's consistently rated one of the top two Java development environments.

Are you interested in Java—for embedded use or otherwise? Let me know; I'm considering adding some ongoing coverage.

See you next time. Until then, you can drop me a line via e-mail at jeff@ingeninc.com. EN



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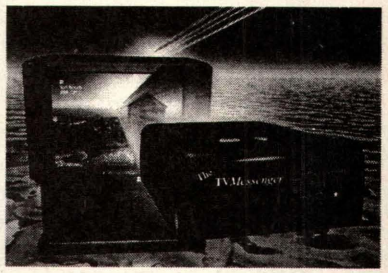

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BY SAM GOLDWASSER
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Common CD-Player/CD-ROM Problems and Cures

LAST TIME, WE DID SOME GENERAL MAINTENANCE TASKS SUCH AS CLEANING AND LUBRICATION. IN MANY CASES, THAT MIGHT BE ENOUGH TO RESTORE YOUR PLAYER OR DRIVE TO NORMAL OPERATION. THIS MONTH, WE'LL TURN OUR ATTENTION to what to do when such general maintenance is not enough.

CD Player is Dead as a Brick

If the heading above more-or-less summarizes the state of your unit, the first step is to check the obvious. Make sure the input power cord is plugged in and good, inspect the fuse (if present), and verify that the power switch (if present) is functioning normally. Also make sure that the outlet to which your unit is connected is indeed supplying power and/or that the batteries are good.

After that, you must turn your attention to the power-supply components. Locate the outputs of the power transformer and trace them to the rectifiers and associated filter capacitors and regulators. While the actual voltages will probably not be marked, most of the power in a CD player will be within ±15 VDC. The voltage ratings of the filter capacitors and regulators, if you can read them, will provide clues as to the correct power-supply voltages.

Most component CD players use linear power supplies so troubleshooting is straightforward even without a schematic. For reference, the power-supply schematic for a Technics SLP-310 is shown in Fig. 1. That unit is typical of those that use either discrete pass transistors (as in this case) or common IC regulators like the 7805, 7815, 7915, and similar devices.

Portable CD players and CD-ROM drives often use DC-DC converters to produce the various voltages required, and those are much more difficult to troubleshoot, even with a complete service manual. Doing anything other than checking for shorted or open components is virtually impossible without an accurate schematic.

Power-Adapter Blues

When it comes to portables, one of the common causes of damage is the use of an incorrect power adapter. When it comes to CD-ROM drives, connecting or disconnecting the power lead while power is being supplied is also a definite no-no. In either case, major damage can result despite the various types of protective measures taken in the design.

If that is the cause of the malfunction in the unit you are attempting to repair, all might be lost, Even so, check for the obvious—a blown fuse on the main board near the power connector—before giving up. These may be *picofuses.* which look like little green resistors; IC Protectors, which look like tiny transistors with only 2 legs; or something else marked F, ICP, etc. Who knows? You might get lucky.

Then again, you might not. For example, I once inherited a Sony Discman from a guy who thought he would save a few bucks and make an adapter cord to use it in his car. Not only was the 12–15 volts from the car battery too high, but he got the polarity backwards! He blew the DC-DC converter transistor in two, despite the built-in reverse-voltage protection, and he fried the microcontroller. Needless to say, the player was a total loss, except for some of the mechanical parts, which I salvaged for future use.

The moral of this story is that the voltage, current, and polarity ratings marked on portable equipment are there for a reason. Voltage ratings should not be exceeded. Using a slightly lower-voltage converter will probably cause no harm, though performance could suffer. The current rating of the adapter should be at least equal to the printed rating of the equipment you intend to power. Polarity, of course, must be correct. If you are not 100% certain of your adapter's output polarity, double check it with a voltmeter before plugging it in.

Keep in mind that some identically marked adapters deliver widely different open-circuit voltages. If the unloaded voltage reading is more than 25% to 30% higher than the marked value, be cautious about using the adapter. If the player acts in any strange or unexpected way with a new adapter, if any part gets unusually warm, or if there is any unusual odor, unplug it immediately and attempt to identify the cause of the problem.

Unit Works, But No Display

Sometimes the display is backlit by miniature incandescent lamps. After a while, these burn out. If you take some time, you can probably find an inexpensive alternative to the high-priced exact replacements. Test any suspect lamps with your ohmmeter. Measure the voltage across the lamp terminals and then replace the lamp with one that is rated at a 25% to 50% higher voltage. They may not be as bright, but will last a long, long time.

If the lamps are not at fault, or if

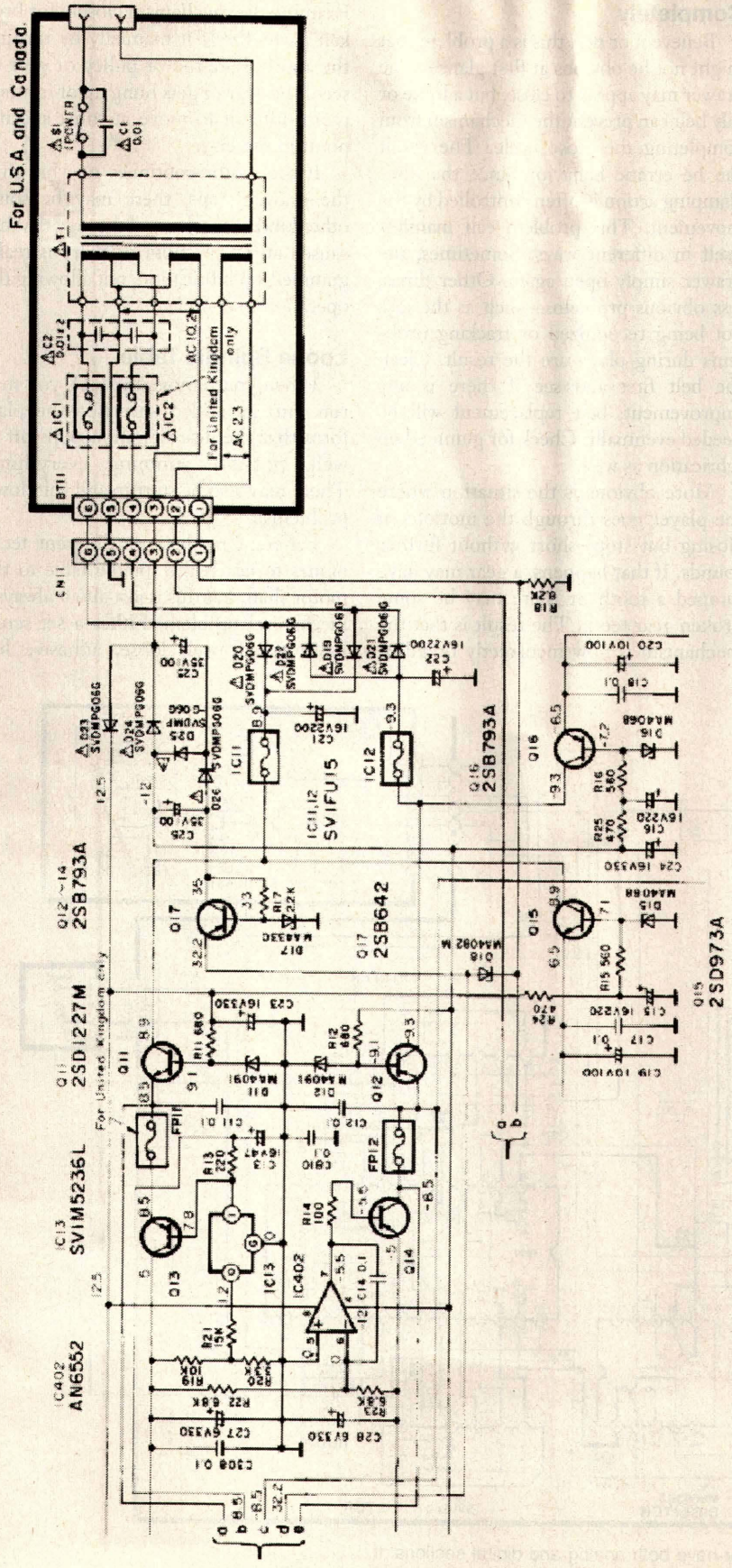

FIG. 1—MOST CD PLAYERS, like this Technics SLP-310, use a linear power supply, so troubleshooting is usually fairly straightforward.

there are no lamps, check for power to the display. At the same time look for bad connections or connectors that need to be re-seated. There might also be a power-supply or driver problem such as a missing voltage for a vacuum fluorescent display.

CD Player Ignores You

Symptoms here are that the display comes up normal when power is turned on, but all, or some commands are ignored. There are several possible causes:

- Front-panel problem: If one or more buttons are not responding, try to re-seat the internal cables. Clean or replace the offending switch or switches. If the player has a remote control, see if it is operating correctly.
- Reset failure: If the player has failed to reset properly and is not ready for user input, check the power-supply voltages and re-seat internal connectors.
- Controller and/or driver electronics: These could be defective for the affected functions. Once again, check the power-supply voltages and re-seat the internal connectors.

Drawer Does Not Open or Close

If the drawer does not open when the front-panel button is pressed, listen for a motor attempting to open it. If you hear the motor whirring but nothing happens, check for an oily or loose belt, or another mechanical fault. You can clean the belt as a temporary repair, but replacement will be needed eventually. If there is no motor sound (listen carefully), the motor, control chip, or front-panel pushbutton could be bad. If the unit has a remote, see if it will open the door. If it does, check the pushbutton for that function on the unit first.

Erratic Drawer Operation

You are about to remove your favorite CD from the unit but the player beats you to it—it closes the drawer and starts to play the disc over again. Other symptoms are that the drawer reverses course halfway out, or the drawer motor continues to whir even after the door is fully open or closed, and the front panel is then unresponsive.

These kinds of problems are usually caused by dirty contacts on the door-position sense switches. There are usually three sets of switch contacts associated with the drawer mechanism. If any of those get dirty, worn, or bent out of place, erratic door operation results.

Those sense switches are:

- Drawer-closed sense switch. Dirty contacts may result in the drawer motor continuing to whir after the door closes and the front panel may then be unresponsive. Eventually, the door may open on its own.
- Drawer-open sense switch: Dirty contacts may result in the drawer motor continuing to run after the door opens and the front panel may then be unresponsive. Eventually, the door may close on its own.
- Drawer-pushed sense switch. Most CD players allow the user to start play by gently pushing on the drawer. That depresses a set of switch contacts. If these contacts are dirty, the drawer can decide to close on its own or to reverse direction in the middle of opening or closing.

The solution to all three of these problems is to locate the offending switches and clean their contacts. Those contacts are rarely protected from dust, dirt and grime. As a result, the problems outlined in this section are quite common.

Drawer Does Not Close Completely

Believe it or not, this is a problem that might not be obvious at first glance. The drawer may appear to close, but a loose or oily belt can prevent the mechanism from completing the close cycle. The result can be erratic behavior, since the disc-clamping action is often controlled by the movement. This problem can manifest itself in different ways. Sometimes, the drawer simply open again. Other times, less obvious problems—such as the disc not being recognized or tracking problems during play—are the result. Clean the belt first and see if there is any improvement; belt replacement will be needed eventually. Check for gummed up lubrication as well.

More obvious is the situation where the player goes through the motions of closing but stops short without further sounds. If that happens, a gear may have jumped a tooth or there may be some broken gear teeth. The result is that the mechanism is now incorrectly timed or not able to complete the operation. Examine the mechanism closely for broken parts. Cycle it manually by turning the appropriate motor pulley or gear to see if the drawer gets hung up or is much more difficult to move at some specific point in the cycle.

If the motor continues to whir after the drawer stops, there may be some other kind of mechanical damage that has caused an obstruction, or there is really gummed-up lubrication, not allowing the operation to complete.

Loose Spindle Table

When you remove the CD, you may run into an added surprise—the platform that the disc sits upon pops off as well, possibly jamming everything. There may also be startup and spindown problems.

Different models use different techniques to fasten the spindle table to the motor shaft, but this is just about always a mechanical problem. Either a set screw has worked itself loose, adhesive has

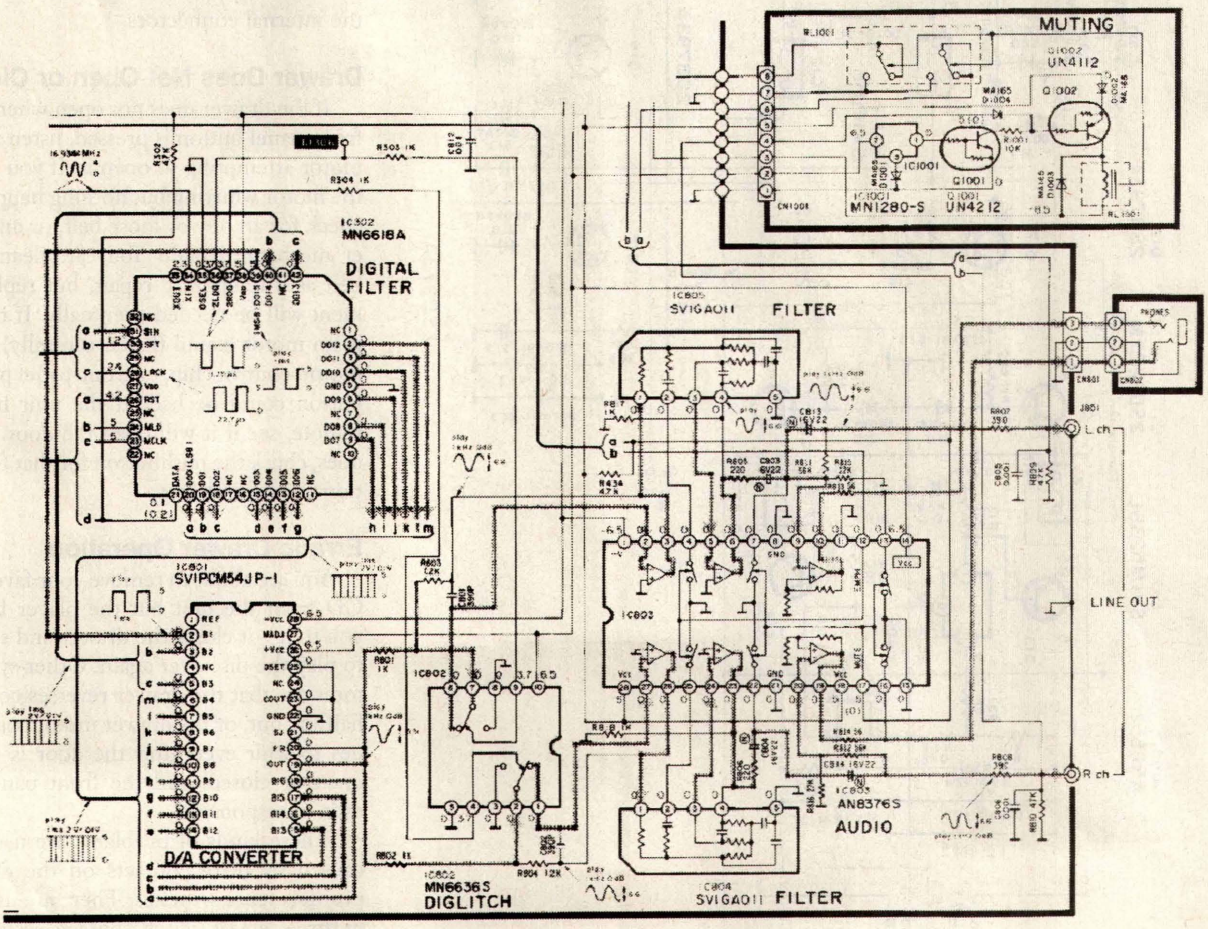

FIG. 2—THE AUDIO CIRCUITS in a CD Player have both analog and digital sections. If the problem is in one of the digital LSI chips, there is little you can do. Dealing with the analog circuits is a bit easier.

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weakened, or a press fit has come undone.

If there is a loose or missing set screw, get a new one or tighten the old one. If there is no set screw, a drop of epoxy cement may save the day. However, height is important to guarantee proper focus range, so be careful if there is no definite stop. The disc and rotating clamper magnet must both be clear of any fixed structures and be the correct distance from the optical pickup. Where something irreversible is involved, like using epoxy adhesive, checking the service manual becomes a must—the specification is usually 0.1 mm accuracy.

A loose spindle table can also cause continued spinning upon eject, or sluggish or noisy startup or seek; since if the spindle is loose, the motor cannot properly control disc speed during speed changes.

Intermittent Operation

When a CD player appears to have a "mood" problem—playing fine sometimes or for only part of a disc, or aborting at random times—there are several possible causes. Those include a defective disc, a dirty lens, various mechanical problems, dirty or worn interlock or limit switch, bad connection to the interlock switch (mainly in portables and boomboxes), flex cable with hairline cracks in one or more conductors, other bad connections, missing optical deck ground/shield, or power-supply problems. Let's go through some of those:

• Dirty, Scratched, or Defective CD: It might be easy to overlook the obvious, so the first thing you should do is to confirm that the CD is not the problem. Clean the disc and/or try another one.

• Dirty Lens: A player that accepts some discs and not others, or accepts discs sporadically, may simply need its lens glass cleaned.

• Mechanical Problems: This usually involves oily and/or flabby belts preventing full drawer closing, or gummed-up lubrication on the sled (may fail depending upon ambient temperature). For example, if the music gets stuck at about the same time on every disc, then there may be gunk on the end of the sled track, preventing the sled from moving any further. That is especially likely to manifest itself if you just purchased a disc with an unusually long playing time. NOTE: Some players simply will not play discs that exceed about 74 minutes of playing time, the maximum CD playing time if the CD specification is followed. However, some discs may be as long as 78 minutes or more, which means that some aspects of the CD specifications were compromised.

• Dirty Switches: Oily film or oxidation may be preventing any one of the limit or interlock switches from making a reliable contact. If this is the problem, the player may stop at random times, fail to accept a disc, close the drawer without your permission, etc. Use contact cleaner and typing paper to clean the contacts. Disassembly may be required to get at the contacts of enclosed switches.

• Cracks in Ribbon Cable: The moving and fixed parts of the optical pickup are often joined with a printed flexible cable. Constant flexing may cause one or more of the copper traces to crack. This may show up as an inability to get past a certain point on every disc (the player might shut down or start skipping at about 23 minutes into every CD).

• Bad Connections: There are often many little connectors used to send signals and power between the optical deck and the main circuit board. These are usually cheaply made and prone to failure. Wiggling and re-seating those may cure your problems. There may even be bad solder connections on the pins of the connectors or board-mounted switches. Slight flexing or just expansion and contraction may result in intermittent shutdown or other problems. Note that this type of failure is most common in portables and boomboxes because they are more likely to take physical abuse.

• Missing Shield: A missing shield between the analog ground and the optical deck can result in all kinds of erratic behavior. If your intermittent problems started after you had the player apart for some reason, check that you replaced the grounding strap or metal strip and/or didn't accidentally disconnect or break any shield connection on the ribbon cable to the optical deck.

• Power-Supply Problems: Problems in the power supply could cause the types of intermittent problems listed above, but it is unlikely. That said, if you have an oscilloscope, it certainly does no harm to check the power-supply outputs for ripple—a filter capacitor may have dried up and lost most of its capacitance.

Heat Problems

A CD player that becomes noisy, or a CD-ROM drive that fails to recognize discs or fails to reliably read data after a few minutes of operation, may have a component that is heating up and changing value. There is not very much in a CD drive that runs hot; however, specific components do sometimes fail in this way. The way to diagnose and locate problems of this type is to the use some of the same techniques that you would apply to finding overheating components in a TV or in a computer monitor.

Your main tool will be a can of cold spray ("circuit chiller" or, in a pinch, a hair dryer set to 'no heat'), coupled with an oscilloscope (if one is available). What you are going to do is to try cooling various components to try to identify the one that is bad and causing the problem. However, if you are trying to deal with a unit that dies completely and suddenly after it heats up, this may not work very well since you may not have enough time to detect changes in behavior. If you are dealing with CD player that will play, but has tracking problems and/or audio noise, you should be able to monitor the playback quality by simply listening for improvement when you have cooled the flaky part. For a CD-ROM drive, play an audio disc if possible, since it will provide the feedback you need to locate the bad part without (hopefully) the drive shutting down due to data errors or inability to reliably access the file system.

Here's a good procedure to follow when making this test: First, run the unit with the covers removed and see if that has an effect that confirms a thermal problem. Next, use the cold spray on individual components. Start with a quick burst on an LSI chip and wait a few seconds for something to change. If nothing happens, move on to the next component. If you are using the hair dryer (no heat!), make a funnel out of paper to direct the air flow. Since this is not really cold air, expect to wait a bit longer to see any effect.

If you have a scope available, it would be wise to look at the RF "eye" pattern while cooling components and see if it changes in amplitude and/or quality over the course of an hour. If it does change, you may have an overheating problem in the laser diode or its power supply. (The "eye" pattern will be discussed in a future column, so you may want to hold off until then for this "advanced" troubleshooting!)

Audio Problems

Silly me, what other kinds of problems are we talking about? What I should

have said: audio signal-chain problems. The player appears to be working fine (the disc is spinning; the time is incrementing correctly; seek, search, and play operations behave normally) but there is either silence, noise, or distortion on one or both channels.

Note: These sorts of audio symptoms could also be caused by problems with servo alignment, the optical pickup, or front-end electronics. Troubleshooting those types of problems will be covered in future columns. Therefore, if your problems are as outlined in the paragraph above, you might want to hold off on attempting to troubleshoot your unit until those topics are covered. Remember, patience is a virtue, and in this case can save you from wasting time troubleshooting a problem in one part of the player when its cause actually lies in another.

Getting back to the audio signal chain, there is a distinct boundary between the digital section where audio information is encoded digitally and the analog domain where it is an electrical waveform. The diagram of the audio circuitry of the Technics SLP-310 in Fig. 2 shows a typical organization. Note the separate circuitry for the D/A converter, digital filter, audio mute, and post analog filtering.

Problems in the digital domain will usually be obvious to the point of being gross—extreme noise, noise correlated with the signal level, extreme distortion, tones or frequencies that with no stretch of the imagination were present in the original music, etc.—and will be distinctly different than the kind of noise or audio distortion we are accustomed to in stereo equipment. Even small errors in the digital reconstruction can result in extreme changes in the audio output. For example, a single bit error if in the MSB can totally corrupt the resulting waveform. Simple errors can result in sound frequencies not present in the original. Fortunately, these sorts of errors are relatively rare as most of the circuitry is inside of very reliable LSI chipsets.

However, if the CD is recognized and appears to behave normally except that there is absolutely no audio output, there can be problems in the audio-decoding LSI chips. Other than hoping for an obvious bad connection, this is way beyond the scope of anything you can hope to repair without the service manual, test equipment, and a miracle.

Problems in the analog sections—D/A(s), sample-and-hold(s), post analog filters, and muting relays—produce effects that are more familiar: noise, a decrease in signal strength, and distortion. Except for parts of the D/A, which may be shared, there will be identical left and right channels to compare if an audio problem develops.

Note that if only one channel is affected, then the problem most likely has nothing to do with tracking, the laser, or the mechanism. Coming off of the disc, the left and right channels are interleaved on a sample (16 bit word) basis so any disc or pickup problem would equally impact both L and R.

That means that you are left with the D/A(s), sample-and-hold(s), the filters, and the muting circuitry as your most likely culprits. Many CD players multiplex the D/A between L and R, so in these, even the D/A is ruled out since most of its circuitry is common.

Now, how do you go about tracking down the source of your problem? Swapping components one at a time between the identical left and right channels is a valid diagnostic technique. Here are some other notes and suggestions:

Players without digital filters (or oversampling) have fairly complex analog filters after the D/A. A bad or noisy component could conceivably be your problem. Even players with fancy oversampling have some kind of a final analog (anti-aliasing) filter. On an older player, there is probably a lot of discrete circuitry in the audio section.

If you can get to the components in the analog filter (some are potted), then, with a test CD that has a "silence track" and a scope or signal tracer, you should be able to find out where the noise is being introduced. If the player has separate D/As, then one of those would also be suspect.

There might be separate power supply outputs for the audio section (this will be more likely with fancy expensive players). In this case, a failure of one of the supply outputs could result in either distorted audio or no sound at all.

The following will mostly result in static type noise, hum, or erratic audio (sound not coming on or partial or total dropout for one or both channels):

Don't overlook the simple problems of dirty contacts on the RCA jacks or bad connections where they are soldered to the main circuit board. Test by jiggling the cable connectors and/or prodding the circuit board near the RCA jacks. The cable may be bad (from flexing) as well—try another one.

Check the connections and controls on your amplifier and other audio components as well! Any bad connection in the audio path can lead to audio signal-chain symptoms. Clean, repair, or replace, as appropriate. Perhaps your poor, helpless CD player isn't even at fault!

Dirty muting-relay contacts could result in intermittent or noisy output. If tapping the relay affects the symptoms, this is likely the problem.

To test, remove the relay and bypass the suspect contacts with jumper wires. CAUTION: Turn your amplifier's volume control down when you start to play a disc—there may be unusual loud noises during startup that are no longer being blocked by the muting circuitry. If CDs now play without any audio problems, a bad relay is confirmed.

If that is the case, it may be possible to snap off the relay cover(s) and renew the relay(s) with contact cleaner and a burnishing tool or a strip of paper. Otherwise, replacement will be required.

Wrap-Up

That's it for now. Next time we will get into what the CD player does when you insert a disc—and what can go wrong. In the meantime, if you have any specific problems or questions, you can reach me by e-mail at sam@stdavids.picker.com. For general information on electronics troubleshooting and repair, visit my site http://www.repairfaq.org/, or go directly to the new, expanded, and glorious FAQs at: http://www.repairfaq.org/REPAIR/F_Repair.html. EN

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Additional and useful features of the RMS225A include ProbeHold, autoranging, overload alert, oversized display characters, and menu selection of features like min/max and range lock. ProbeHold allows capture of the last stable reading and updating to the next stable reading to be done automatically. In Auto Min/Max mode, measurements of maximum and minimum values are displayed. A beeper sounds when the latest reading is captured and when updated values are shown.

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The professional class RMS225A is designed for reliability and continuous trouble-free operation. Its 10,000-count, 4-digit oversized character display allows for high resolution, the most accuracy, and maximum readability. In addition, a 41-segment bargraph display helps adjust peaking and nulling circuits. A simplified menu provides the easiest access to features. Measuring approximately 7- by $3^1/_2$- by 1-inches, this DMM is priced at $189.95 and is available through distributors and catalogs.

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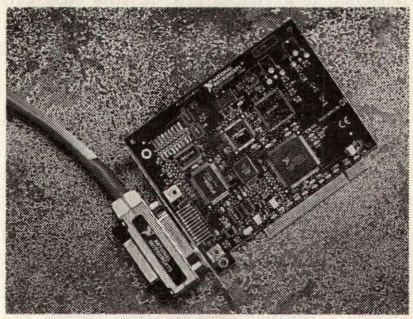
National Instruments' TNT4882 ASIC makes the PCI-GPIB+ a maximum-performance IEEE 488.2 interface, sustaining data transfer rates up to 1.5 Mbytes/s using the IEEE 488.1 three-wire handshake or up to eight Mbytes/s using the popular, high-speed GPIB protocol (HS488). The interface is capable of controlling GPIB instruments as well as troubleshooting a variety of IEEE 488 hardware and software problems. The PCI-GPIB+ can reveal GPIB communication problems, such as addressing inconsistencies, protocol violations, simple bus timeout conditions, and many more.

In addition, the PCI-GPIB+ is completely jumperless and features Plug and Play functionality for easy installation and use. The board comes with standard NI-488.2 driver software. It is also compatible with the company's LabVIEW and



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LabWindows/CVI application software.

Requiring only a single PCI slot, the combination PCI-GPIB+ controller/analyzer delivers a low-cost, high-speed alternative to separate GPIB controller and analyzer products. Pricing starts at $795.

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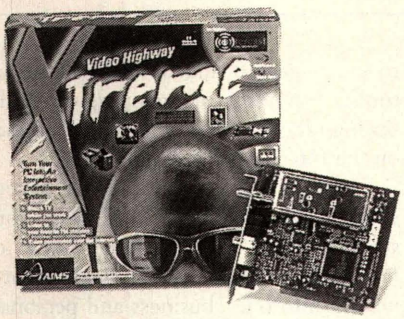
PCI-Video-Capture Card

AIMS LAB RECENTLY ANnounced VideoHighway Xtreme (VHX), a video card that combines every facet of multimedia into an easy-to-use, plug-and-play PCI card. Incorporating Intel Intercast technology, VHX allows users to watch TV, listen to FM radio, use Internet video phones, capture still or full motion pictures, and communicate interactively on their PC. Using VHX, the operator can instantly get more information about a news item, order tickets, purchase products, or participate

in chat sessions—all while watching a TV show.

Besides watching TV, VHX users can connect their VCR, LD, or DVD to watch a movie or connect a Sega, Nintendo, or Sony game console to play a game. VHX also offers video conferencing features and closed captions.



CIRCLE 27 ON FREE INFORMATION CARD

Included with the card is the Intel Smart Guide, a TV program guide that contains a TV program grid, a browser, and a powerful search engine. The bundled VDOphone software allows the connection of a camcorder or CCD camera for instant video conferencing over the Internet. VHX also captures MS AVI video clips at a speed of 30fps (frames-per-second) that can be used in presentations, Web pages, and video e-mail messages.

You can preset up to 99 FM radio stations. With VHX's 125 channel-ready tuner, viewers can also watch TV in the corner of their PC monitor, with the ability to change the image to full-screen mode. The video-capture card requires a Pentium 90 or better, 16MB of RAM, a PCI expansion slot, Windows95 DirectDraw, and 2MB of VGA memory. It retails for $129.95

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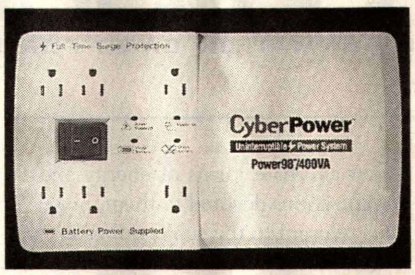
Uninterruptible Power System

CYBER POWER SYSTEMS RECently announced the industry's first full-featured, low-cost surge-suppression and uninterruptible power system, the Power98/250VA. It includes free PowerPanel software, which automatically shuts down the Windows operating system before the computer loses power. This software utility runs under Windows 3.11, Windows 95, and Windows NT. It can be set to automatically save and close any open files within the backup battery time—and to shut down the computer.



CIRCLE 28 ON FREE INFORMATION CARD

With its advanced microcontroller technology and transformer, the Power98 creates less heat than traditional UPS designs, which results in a compact and lightweight design. Ideal for home, small office, and other cost-sensitive computing environments, the device provides three grounded outlets with full-time surge protection and three grounded outlets with both surge protection and battery backup—capable of supplying power up to 13 minutes. Its battery backup combined with surge suppression protects against all power disturbances: blackouts, brownouts, spikes, sags, and even lightning. The system's high-efficiency batteries are designed to last up to 20 percent longer than ones used in traditional power supply systems.

The device includes top-of-the-line features in a compact, easy-to-use system. The programmable shutdown feature in the PowerPanel software allows the user to set the computer to run a job and leave, knowing the computer will be shut down safely and automatically at a certain hour.

The system's exclusive communications protection ports protect standard modems, PBX systems, or 10-Base-T Ethernet networks. It can be used with any IBM- or Apple-compatible computer, as well as with other electronics. The 250VA comes with a lifetime guarantee up to $30,000 to repair or replace any properly connected equipment ever damaged by a surge, including one caused by a lightning strike. The suggested retail price for the Power98/250VA is $109.

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Maritime SSB Transceiver

DESIGNED AS A SMALL, LOW-power, low-cost HF companion to your current radiotelephone, the SG-2020 is ideal for coastal cruising and long-range cruising sailboats, as well as for powerboats. According to the manufacturer, the unit has the lowest current consumption on the market (less than 300 mA in receive mode).

The transmitter power of the SG-2020 is adjustable from 0 to 20 watts PEP output and covers all HF marine frequencies. The rugged SG-2020, with its extruded aluminum chassis, can be used as a standby, emergency backup transceiver in voluntary fittings. You can communicate worldwide with this unit, and listen to marine frequency traffic, or copy weather-fax transmissions. (The SG-2020 is not FCC-type approved.)

CIRCLE 29 ON FREE INFORMATION CARD

Among the features of this radiotelephone are user-friendly functions, including SPLIT, RIT, XIT; a fully adjustable IAMBIC "A" mode keyer operating under microprocessor control from 5 to 50 wpm; 40 position simplex or semi-duplex memory storage; a backlit LCD display; and front-panel controls for noise-blanking and for RF gain control. A "D"-cell flashlight battery pack is also available as an option. Its compact size (2.75- × 6- × 7.25-inches) makes installation easy in any vessel.

The retail price of the SG-2020 is $625. A portable version, the SG-PortaPak (complete with battery pack, microphone case, and shoulder strap) is also available at a retail cost of $1195.

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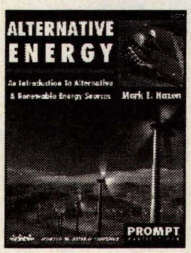

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As populations increase and third-world countries start up more and more industries, the world's need for energy grows exponentially. At the same time, the world energy supply is decreasing just as the demand for oil-based energy is increasing. The demand for fuel is overwhelming the world's ability to produce it. That's why now more than ever, it is urgent to understand the energy problem and the available alternatives.

In this book, the author presents the problems and possible solutions in a clear, easy-to-read manner. He begins with a broad overview of electricity, explaining its various mechanisms from electro-mechanical and electromagnetic to thermo-, photo-, and piezo-electric. Energy is defined, and the basics of potential, kinetic, thermal, chemical, and nuclear energy are discussed.

Further chapters cover these topics in greater depth. Readers are introduced to energy sources that draw from such supplies as wind, sun, and water stored in reservoirs. Energy from the ocean—tides, currents, and ocean-heat storage—are also presented. Review questions are provided for each chapter.

Comprehensive listings of Web sites about alternate forms of energy and the organizations devoted to them, plus Web sites relevant to the subject of each chapter, make this an excellent reference resource. The glossary, index, and bibliography are helpful to anyone researching this subject.

Digital Literacy

by Paul Gilster
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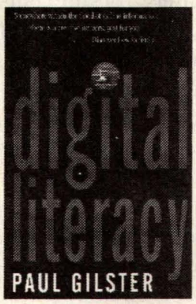

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Using the Internet requires a different way of thinking. Paul Gilster calls this new mindset digital literacy. In his book of the same title, he explains what that mindset entails. He believes that without these new thinking skills, Internet users may be unable to use this medium to its fullest extent.

The book discusses the basic thinking skills needed to thrive in an interactive environment that differs radically from print or television, which are passive media. Internet novices are shown how to evaluate information found in news groups, on bulletin boards, and in other online sources. Readers are taught how to focus search strategies, as well as how to use hypertext and other hypermedia tools. Methods of mapping a path through the wealth of information found on the Internet are explained.

What questions should be asked when viewing a Web site? How do you separate form from content? How to integrate the masses of available information into one's business and personal life? These and other similar questions are discussed in detail.

The author also gives readers a brief glimpse into the future of digital literacy, and he explores other issues such as the question of copyrighting online information.

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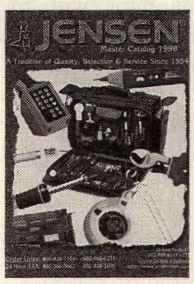

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Jensen's 300-page, full-color Master Catalog is now available. It offers full lines of products for the worldwide electronic/electrical industries. The latest edition contains many new items, organized in a special section, such as power drills, a reciprocating saw, test meters, a stereo inspection microscope, a paging system, multipurpose scissors tool, torx driver sets, and much more.

In addition to Jensen's top-of-the-line tool kits, this catalog covers test equipment; specialty hand tools; wire and cable; power tools and measurement instruments; and devices for soldering, storage, and handling. Among the other products are work stations and static-control sys-

(Continued on page 71)

BUILD A SUPER-SENSITIVE HEAT DETECTOR

SKIP CAMPISI

Detect hot or cold objects remotely with this ultra-sensitive infrared-sensing device

Measuring and sensing temperature has resulted in many different methods and devices. While some of the solutions developed meet certain requirements such as temperature range and accuracy, most have some sort of characteristic that makes them unsuitable for the average home hobbyiest.

Sensors such as thermocouples, thermistors, and exotic ICs usually require their own "flavor" of circuitry in order to use their outputs. The outputs are also usually non-linear and change only slightly in relation to the temperature change. The result is a system that can easily be inaccurate because of circuit noise being interpreted as temperature change.

Fortunately for the home experimenter, materials and components are readily available for building an inexpensive non-contact type of temperature sensor that overcomes the limitations listed above. Such a device is presented here. The unit actually indicates the temperature *difference* between the temperature of an object and an arbitrary "ambient" temperature reference that can be set at any time.

A gain control is used to adjust the sensing range from 1° C down to an incredible 0.01° C between the sensor and the ambient reference temperature! While that specification might sound like "design overkill," it is really quite essential for remote sensing. For example, a match flame can be detected up to a distance of one foot at the 1° C gain setting. With the gain increased to detect a difference of 0.1° C, the heat from the palm of your hand can be detected at the same distance. At the maximum gain setting, that same match flame can be detected from across a room!

Obviously, those objects are all more than 1° C hotter than room temperature, so why is such a high gain needed? The culprit is, of course, the "column" of air between the object and the sensor. As the air absorbs and dissipates some of the heat, the apparent temperature falls off rapidly in an inverse-square relationship with the distance—double the distance, and the heat energy drops by a square-root function. By the time the heat reaches the sensor, we are probably sensing convection currents more than the actual direct heat from the object.

The implication is that any air flow will disturb the readings. When using the device at higher gains, still air is the biggest requirement for consistent results. Avoid fans, heat vents, and the like when experimenting. Of course, that "disadvantage" can also become an advantage, expecially when using the unit to *detect* air flow such as "leak" testing.

About the Circuit. As you can see on the schematic diagram in Fig. 1, the actual circuit for the Heat Detector is a deceptively simple design. Remember, however, that the signals involved with sensing a heat source at a distance are very low in amplitude. Low-amplitude signals always run the risk of being lost in the normal background noise that they are sitting in, so all of the components were selected for low-noise performance. For example, notice that all of the fixed resistors are 1% metal-film units. Those types of resistors perform extremely well when low noise is important. What is interesting in the overall design is that the actual values of the resistors are *not* critical—any value within 5% or even 10% of those given should work well. However, the metal-film composition of the resistor is mandatory!

The circuit is a "current mirror" stretched to the ultimate degree. The current mirror itself is built around Q1 and Q2, a pair of surface-mount transistors. The tiny mass of the SOT-23 transistor package lets the circuit respond extremely fast to temperature changes.

A standard current-mirror circuit would only have Q1 and Q2 with their bases and emitters connected in parallel and the base of Q1 shorted to its collector, forming a diode-connected transistor. The current

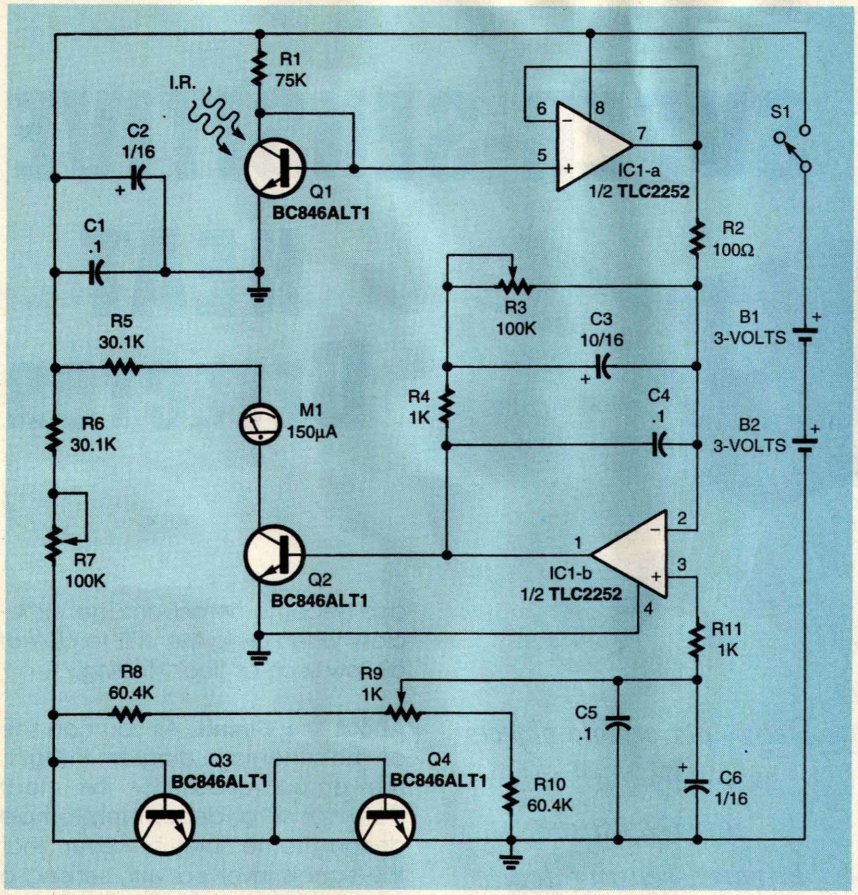

Fig. 1. The Heat Detector is built around a simple current-mirror circuit. When one transistor is heated up, the change in its current flow is reflected in a parallel circuit.

flowing through R1 would then be "reflected" in Q2's collector. For both currents to be equal in size and temperature tracking, Q1 and Q2 are normally a matched pair in a single package. However, the characteristic that we are looking for is the temperature *difference* between Q1 and Q2; that is why individual units are used. For every 1° C increase in the junction temperature of a silicon transistor at a fixed bias current, its forward-bias voltage decreases by about 2 millivolts. By holding Q2 at a fixed ambient temperature, its collector current will decrease as Q1's temperature rises.

A change of only 2 millivolts is not a lot to work with in a remote-sensing circuit, especially if we are interested in displaying a difference of 0.01° C. Besides, an *increase* in current for an increase in temperature would be very desirable.

Placing Q1 outside of the cabinet at the focal point of a standard parabolic flashlight reflector makes the sensor very directional and extremely sensitive to infrared energy focused by the reflector. The rest of the components are located inside a fully-enclosed cabinet that is used as an ambient-temperature reference.

Between Q1 and Q2, a two-stage inverting variable-gain amplifier made up of IC1-a and IC1-b provides the high gain needed for remote sensing. The first stage (IC1-a) is a unity-gain buffer that drives the second stage (IC1-b). The second stage is an inverting amplifier with a gain that can be adjusted between about –10 and –1000 with R3. The audio taper of R3 makes adjusting easy; the most useful gain setting, –100, is at about the center of its rotation.

A 1.2-volt reference, built around Q3 and Q4, tracks temperature changes within the case at a rate of –4 millivolts per degree C. The reference is divided exactly in half, using R8–R10, to a 0.6-volt reference tracking at –2 millivolts per degree C. That output is applied to the reference input of IC1-b. Note that the bias resistors for the transistors have been chosen so that Q1–Q4 all operate at the same current level. That will help ensure that their forward voltages are approximately equal, assuming that they are at the same temperature.

The 0.6-volt reference acts as a "ground" reference for the input signal from Q1. When Q1 heats up by 1° C, its forward voltage decreases by 2 millivolts. With the reference set by R3 to its minimum gain of –10, the voltage appearing at Q2's base and emitter increases by 20 millivolts, which about doubles its collector current. The result is a full-scale display on M1. At a gain of –1000, a 0.01° C increase results in a 20 *microvolt* signal giving a full-scale display! With Q1 at ambient, Q2 conducts enough current for a 50%-of-full-scale display on M1.

As you might suspect, setting the operating levels of the transistors is crucial in order to get any meaningful results out of the instrument. That is done by leaving Q1's current fixed and varying the current to Q3 and Q4 with R7. When adjusting the 1.2 volt reference, R7 can be considered as a "coarse" adjustment. Any "fine" adjustments are then done with R9.

The collector of Q2 directly drives M1, an analog current meter. Although the circuit uses a 150-microamp unit, you can use any analog meter that has a full-scale display between 50 and 250 microamps. Keep in mind that the markings on the meter do *not* indicate any particular temperature reading, just the relative change. If you are going to use a meter of a different capacity, R1, R5, and R6 must be changed in order for the circuit to work. The different values for those components are shown in Table 1 for several different types of meters. Those resistors have been selected to provide current through the transistors so that they all operate at about 50% of M1's full-scale current. The meter is protected from excess current by R5.

The total current drain of the circuit is only about 300 microamperes when M1 is a 150-µA unit. A simple unregulated power supply is quite suitable in that case. Two 3-volt lithi-

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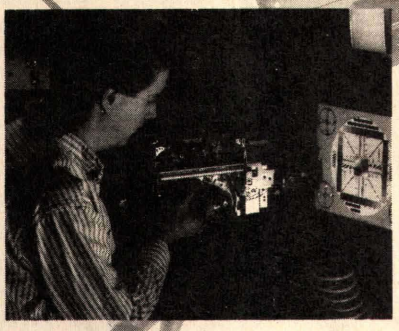

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um coin cells are connected in series for a 6-volt supply. With a rating of about 200 milliamp-hours, they will last a long time. They also have a very "flat" discharge voltage curve, simulating a regulated power supply at those low currents.

One final consideration for this type of circuit is the concern over external noise pickup, such as 60-Hz hum and radio-frequency interference (RFI). Capacitors C1–C6 were specially selected to filter out as much noise as possible while still keeping response times very fast. Tantalum capacitors are highly recommended. If you have noise problems, the values of the capacitors can be increased. You can even connect the parabolic reflector to ground through one of its mounting screws if necessary.

Construction Tips. The Heat Detector's circuit is simple enough that it can be built on perfboard using standard construction technuques. One area that will be a bit more difficult is connecting the tiny surface-mount transistors to the circuit. The simplest method is to attach separate leads directly to the units, converting them to through-hole-like devices. They can then be mounted to a perfboard like any other standard leaded part. The technique is shown in Fig. 2. Use 30-gauge wires that are at least 1-inch long for the leads—the excess length can be trimmed off after the unit is mounted to the board. In order to help protect the transistor from heat-related damage during soldering as well as making it easier to handle the tiny parts, hold the transistor case with a "micro-gator" clip such as a RadioShack 270-373. That particular clip has flat jaws rather than serrated teeth.

Using small tweezers, carefully bend the transistor leads out flat from the case. Wrap a turn or two of wire around the unit's leads with the tweezers. Put the clip in a bench vise and attach another clip to the free end of the wire so that it acts as a weight, stretching the wire. Using very fine solder and a very fine tip on your iron, carefully solder the wire to the lead. Use as little heat as possible for a very brief time in order to avoid damaging the transistor.

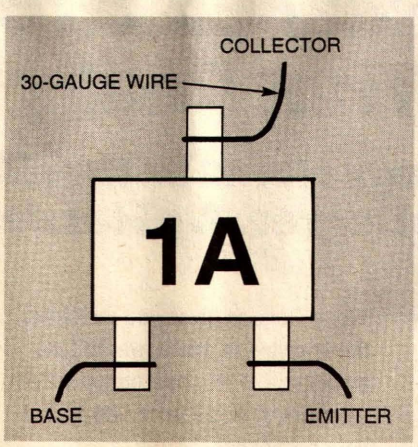


Fig. 2. Surface-mount transistors can be converted to use with perfboard with some careful work.

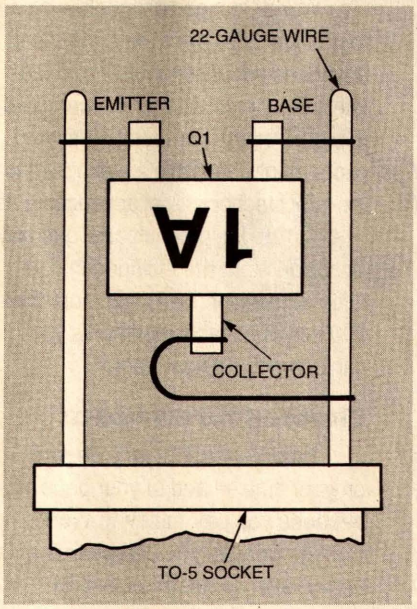


Fig. 3. Transistor Q1 is mounted to a TO-5 socket so that it can be moved to the focal point of a parabolic reflector.

Repeat the procedure for all three leads on all four transistors. Once the solder joints are cool, check the transistors with an ohmmeter to verify that the transistors were not damaged during soldering.

The BC846ALT1 transistors specified for Q1–Q4 are general-purpose NPN small-signal units. Any similar type of device can also be used. Examples of alternate part numbers include BC848ALT1, MMBT3904LT1, and MMBT4401LT1. Note, however, that it is important that all of the transistors are the same device type in order for the correct matching of transistor characteristics. In other words, don't mix and match when selecting parts for Q1–Q4.

When laying out the components on the perfboard, it is a good idea to place R3, R7, and R9 along one side so that their controls point in the same direction. Since R7 and R9 are 20-turn units having only a small adjustment screw, it would be convenient to use some sort of panel-knob adapter for them. Such a device is available from Spectrol for their line of multi-turn potentiometers. Other manufacturers might have similar devices available. The adapters should be mounted to the potentiometers according to the manufacturer's instructions.

Transistors Q3 and Q4 should be installed between R7 and R9 with their cases sitting about ¼-inch above the board for good air circulation around the transistors. Mount Q2 in a similar fashion. Remember that Q1 will not be mounted on the board; it will be discussed later.

Next, select a plastic cabinet that is large enough to hold M1, S1, and the completed circuit board. Cut an appropriate hole for M1; locate and drill the three mounting holes for R3, R7, R9, and S1. The board will be supported by the three potentiometers.

A parabolic reflector from a flashlight or lantern will be used for the collector. Although the size can vary depending on what you have available, a 3-inch-diameter reflector from a 6-volt lantern is a very effective size for the intended use.

Select a transistor socket that will fit through the light-bulb hole at the base of the reflector. A standard TO-5 or TO-39 socket should be fine in most cases. However, it might be necessary to use a smaller TO-18 socket. Install the socket in a hole centered in one end of the cabinet, using silicone sealant to hold it in place if necessary.

Drill a couple of clearance holes through the base of the parabolic reflector on either side of the light-bulb hole for a pair of 2-56 or 4-40 mounting screws. Place the reflector over the transistor socket and mark and drill the screw holes.

Using Fig. 3 as a guide, insert two 1-inch lengths of 22-gauge tinned solid-bus wire into the two widest-spaced holes in the transistor socket. Install Q1 by carefully wrapping its wire leads from its base and

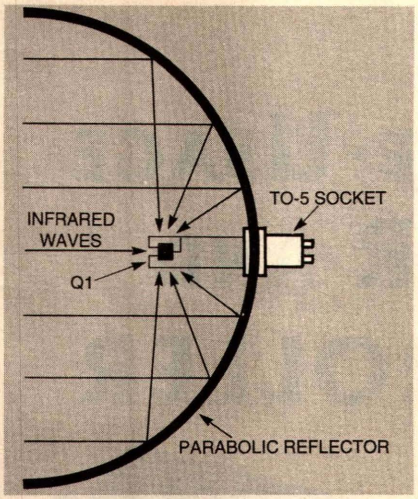


Fig. 4. When Q1 is at the focal point of a parabolic reflector, all of the gathered heat energy will strike the transistor. The size of the reflector will increase the ability of the Heat Detector to collect energy from the source of heat, increasing the gain of the system.

PARTS LIST FOR THE HEAT DETECTOR

SEMICONDUCTORS

IC1—TLC2252 CMOS dual op-amp, integrated circuit (Texas Instruments)
Q1–Q4—BC846ALT1 Surface-mount general-purpose transistor, NPN (see text)

RESISTORS

(All resistors are ¼-watt, 1% metal-film units, unless otherwise noted.)
R1—75,000-ohm (see text)
R2—100-ohm
R3—100,000-ohm potentiometer, audio-taper
R4, R11—1000-ohm
R5, R6—30,100-ohm (see text)
R7—100,000-ohm potentiometer, 20-turn (Spectrol)
R8, R10—60,400-ohm
R9—1000-ohm potentiometer, 20-turn (Spectrol)

CAPACITORS

C1, C4, C5—0.1-µF, monolithic ceramic
C2, C6—1-µF, 16-WVDC, electrolytic
C3—10-µF, 16-WVDC, electrolytic

ADDITIONAL PARTS AND MATERIALS

B1, B2—3-volt lithium battery (CR2032 or similar)
M1—Analog panel meter, 150-µA (see text)
S1—Single-pole, single-throw switch
3-inch parabolic flashlight reflector, enclosure, battery holder, wooden or plastic handle, knobs, shaft adapters for R7 and R9, hardware, etc.

emitter around the 22-gauge wires as shown—do not solder the connections just yet.

Carefully slide Q1 on its leads to about the center of the 22-gauge bus wires. Attach the reflector to the case without disturbing Q1. With everything assembled, Q1 should be at a point close to the focal point of the reflector, similar to the arrangement shown in Fig. 4. It does not have to be exact at this point; we will next be adjusting the assembly's focus. Set the reflector assembly down on a table or bench so that you can look directly down the "business" end of the reflector at Q1.

Starting at a distance of about a foot or two away from the reflector, look at the "image" of Q1 in the reflector. You should see a black "ring" somewhere around the reflector's inside circumference, either towards the front or rear. The black ring is the focused image of Q1's case. If you don't see the ring, try sliding Q1 further in or out and look again; it might take a little practice. What you see should look similar to the view shown in Fig. 5.

Once you see the black ring, move farther away from the assembly while keeping the ring in sight. What you want to end up with is the black ring just about filling the forward (widest) section of the reflector from a distance of around 8 to 10 feet. That is a good focal point for indoor use of the Heat Detector. Slide Q1 in and out a little at a time to achieve that focus.

You can confirm a good focus by pointing the reflector directly at a diffuse light source across the room such as a lamp with a shade or a sun-lit window curtain. Peek over the edge of the reflector, and you should see Q1 glowing like a lamp as the focused light shines on it. DO NOT point the unit directly at the Sun or you might melt or severely damage the transistor!

Once you have a good focus, carefully remove the reflector and solder the base and emitter wire leads of Q1 to the 22-gauge wires. Wrap the collector wire lead of Q1 around the 22-gauge wire connected to Q1's base lead and solder that connection also. Re-check the

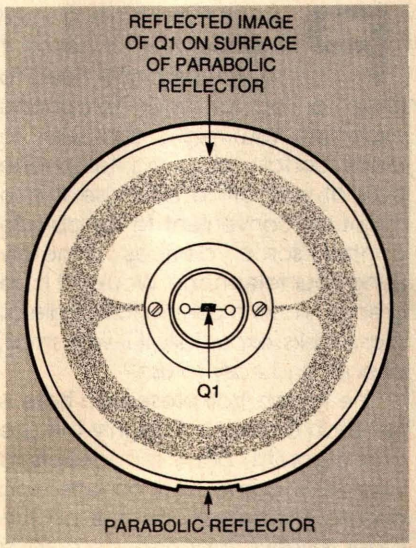


Fig. 5. When focusing Q1, you should see a black band around the surface of the reflector. Careful adjustment of Q1 can vary the apparent size of the reflector to the rest of the circuit.

TABLE 1

ALTERNATE RESISTORS FOR M1

M1	R1	R5	R6
50-mA	215k	90.9k	100k
100-mA	110k	45.3k	49.9k
150-mA	75k	30.1k	30.1k
200-mA	53.6k	22.1k	20k
250-mA	43.2k	18.2k	15k

focal point; if everything looks good, cut off the excess 22-guage wires.

Select a non-metallic handle, such as a plastic or wooden one, and mount it to the opposite end of the case. It is important that the handle not conduct any heat from your hand, or the accuracy of the unit will be affected. If you use a handle from a wood file, the threads in the handle will make it easier to mount the handle to the case.

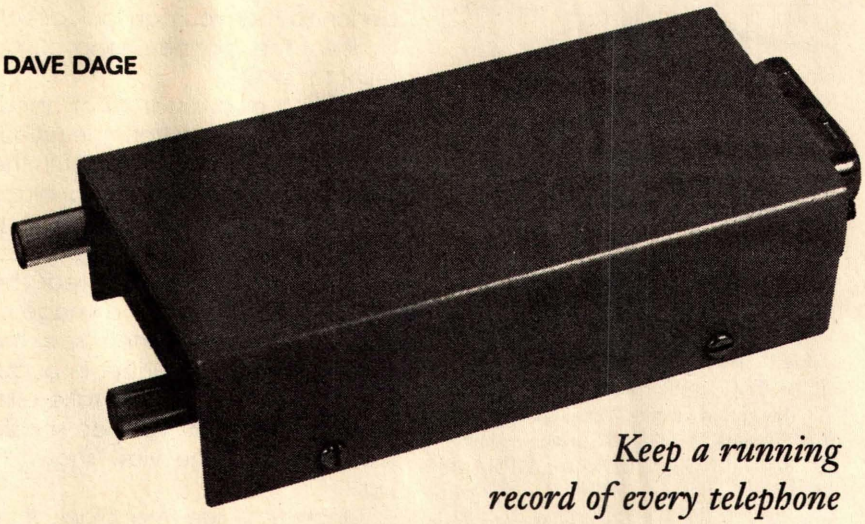
Now you can finish up assembling the Heat Detector. Install the board, S1, and M1, and then wire up the rest of the circuit. If you want to label any of the controls, that should be done before installing any other parts. When wiring Q1 into the circuit, pay careful attention to the polarities of that component.

Install the reflector, the handle, and close up the case. Install the knobs on the potentiometers and set the unit aside for at least 15 minutes to let the temperature inside stabilize after all of the handling it just received. You are now ready to test.

(Continued on page 50)

BUILD A TELEPHONE-USAGE MONITOR AND CONTROLLER

DAVE DAGE



Keep a running record of every telephone call placed or received, or even control other devices with a simple telephone call!

Perhaps you have a small business in your house. If so, you probably need to keep a log of your telephone expenses. You might also wish to block certain outgoing telephone calls at your office or house. It also might be convenient to be able to control some devices remotely using your telephone. Wouldn't it be great to have a device to handle all those tasks, expecially if it was small, cheap, and easy to use?

The Phone Troll presented here is just such a device. Roughly the size of a cigarette pack, it connects to your PC's game port on one end and to the telephone line on the other. It converts phone-line current and DTMF dialing tones into digital signals that are compatible with a game port. With a simple Qbasic program, the Phone Troll can be used for many different tasks.

The "Troll" part of the device's name as used here actually has two meanings. The obvious one relates to the mythical creature that lurks undetected, lying in wait to monitor and record every telephone transaction in your home or business. Information that can be logged each time the phone is used includes the start and end times that the phone was in use, what number was dialed, what dialing buttons were pressed during the call, when an incoming call was received, how many times the phone rang before being answered, and whether or not it was answered.

When the telephone is in use (off-hook), the Phone Troll records all valid DTMF signals—including the additional four tone combinations that are not normally a part of the standard 12-button keypad. This will provide a permanent record of all telephone numbers dialed as well as any other digit activity.

The second meaning of "troll" can be loosely translated into "control". Since the DTMF signals are decoded by a QBasic program, they can be used to signal the program to do some particular task—including control some electrical device connected to the computer's parallel port. The QBasic program is able to detect special control numbers that you can set. By simply lifting the telephone and pressing the proper control code, you can individually turn on and off any of up to eight outputs on the parallel port. To demonstrate that function, a parallel-port monitor plug with light-emitting diodes will also be built.

The control codes used in the Qbasic program are three digits long. When the Phone Troll is active, pressing a three-digit code will turn on or off a single output bit. You can activate the control by simply picking up any telephone that the Phone Troll is connected to, entering a three-digit code, and then hanging up. That feature will also work while talking to someone else. The three-digit code can be entered at any time without disconnecting the call. You can also place a call to your home or office from anywhere in the world, enter the desired control code, and turn an output bit on or off. Of course, the telephone must be answered in order to activate the Phone Troll, but that can be done either by a person or by an answering machine.

Calling home from your car phone just to flip the status of an LED on the back of your computer might not sound like an exciting way to use a pile of expensive high-tech gear. But when the LED is replaced with an opto-isolator acting as a solid-state relay, practically anything electrical can now be controlled by your PC. For instance, turning on a furnace or an air conditioner a couple of hours before you arrive home from a vacation would definitely have some merit. The program listed here needs no modification; it will accomplish all those tasks as written.

One non-obvious use for the Phone Troll is placing the contacts of a single-pole normally-closed

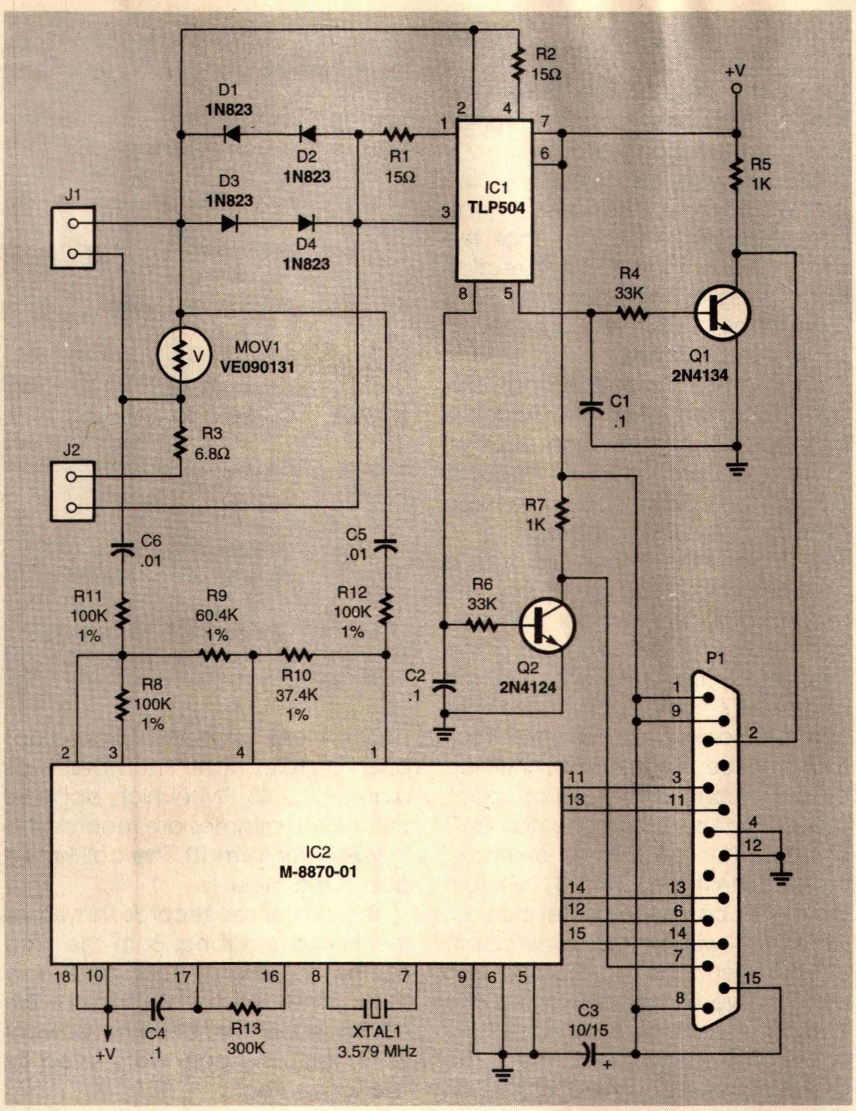


Fig. 1. The Phone Troll is a simple circuit that can sense both telephone usage and DTMF tones. A QBasic program logs activity and can even control other devices.

relay in series with the telephone line. Modify the program to sense the first digit or several digits being dialed on a new call. If the number being dialed starts with a "1" or "1900", activate the relay for a half second. Guess what? That will stop unauthorized persons from using your telephone to place long distance calls or calling any of the "1-900" numbers. The program should also contain a code to enable and disable that function. No one without the proper code would be able to access any long-distance numbers using your telephone.

Note that this arrangement would not be able to prevent operator-assisted calls, unless you also include "0" in the list of numbers on the restricted list. However, doing that is not a good idea—especially as it could be necessary to contact the operator in the event of an emergency.

Yet another use for that "hang-up-the-telephone" technique relates to ordering merchandise from one of those "shop-at-home" TV channels. It's easy to write a QBasic program to test each DTMF digit being entered on the telephone. Have the Phone Troll watch for a string of digits that match any of the family or business credit-card numbers. When one of those numbers is detected, pulse the relay as detailed above. The person will be wondering why the telephone would mysteriously disconnect.

Project Overview. The Phone Troll circuit attaches to the game port on a PC with a standard 15-pin connector. Power for the Phone Troll is supplied by the PC though the game port. The telephone line connects to the opposite end of the Phone Troll through a standard telephone jack. The device is secured to the game port with two mounting screws. Load and run the program, and you're in business.

The Phone Troll has two separate

PARTS LIST FOR THE PHONE TROLL TELEPHONE-USAGE MONITOR

SEMICONDUCTORS

IC1—TLP504 opto-isolator, integrated circuit
IC2—M-8870-01 DTMF decoder, integrated circuit
D1–D4—1N832 silicon diode
MOV1—VE090131 metal-oxide varistor, 38-joule, 130-volt rms
Q1, Q2—2N4124, NPN transistor

RESISTORS

(All resistors are ¼-watt, 5% units, unless otherwise noted.)
R1, R2—15-ohm
R3—6.8-ohm
R4, R6—33,000-ohm
R5, R7—1000-ohm
R8, R11, R12—100,000-ohm, 1%
R9—60,400-ohm, 1%
R10—37,400-ohm, 1%
R13—300,000-ohm

CAPACITORS

C1, C2, C4—0.1-µF, ceramic-disk
C3—10µF, 15-WVDC, electrolytic
C5, C6—0.01-µF, 5%, Mylar

ADDITIONAL PARTS AND MATERIALS

XTAL1—3.579545 MHz crystal, HC49/U case
J1, J2—RJ11 telephone jack, PC-mount
P1—15-pin "D"-style male connector, PC-mount
Case, hardware, etc.
Note: The following items are available from: Dage Scientific, PO Box 144, Valley Springs, CA 95252, Tel: 209-772-2076: Kit of all parts, PC board, and manual (without case or program diskette), No. FT-1, $26.95; Case, No. FT-2, $9.95; Program on 3½-inch diskette, No. FT-3, $2.00. Please add $4.00 for shipping and handling. CA residents must add appropriate sales tax. Visa and Mastercard are accepted on telephone orders.

IC2 can be ordered in single quantities from: ICS, Inc., 2222 E. Camelback Rd. # 222, Phoenix, AZ 85016-3427; Tel: 602-224-5322.

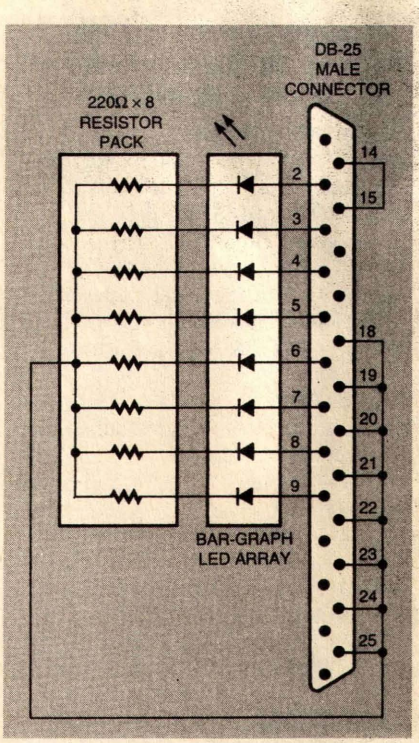


Fig. 2. The test fixture simply connects 8 LEDs to the data lines of a printer port. Connecting pins 14 and 15 together helps the Phone Troll program find the port that the test fixture is connected to.

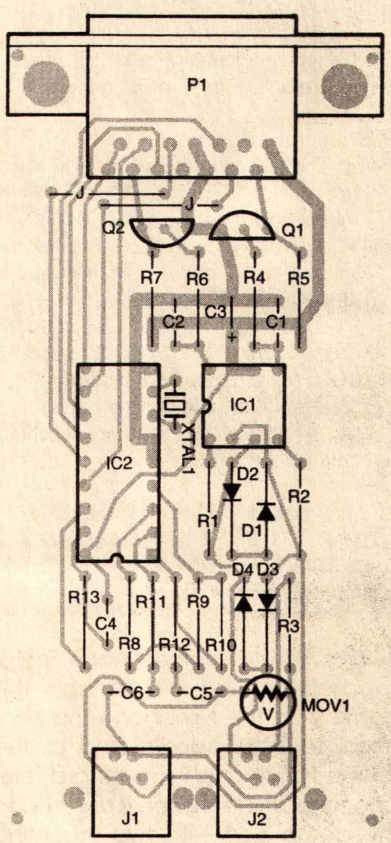


Fig. 3. The Phone Troll fits easily on a single-sided PC board. Only two jumpers are needed.

circuit functions, each of which runs independently. One function is the monitoring of the telephone line continuously for DTMF tones. The other function watches for any current flow in the telephone line that would mean that a telephone has been picked up or that the telephone is ringing. The direction and timing of that current flow is used to tell the difference between those two situations.

The sample program that has been included here also watches for a special combination of DTMF tones that are used as "control codes." The control codes are three digits long. The first number is the "#" key; it alerts the Phone Troll that a control code is being issued. The second digit is a number between one and eight. That number points to one of the data lines on the computer's printer port. Those lines can be hooked up to any circuit that can be electrically controlled by a TTL-compatible digital signal. The last digit is either a one (for "on") or a zero (for "off"). As an example, pressing the three keys "#81" will turn the eighth bit on the printer port on, while "#80" will turn the same bit off.

Any telephone activity will also be displayed immediately on the computer's screen. After each telephone transaction is finished, the information will be saved to a file on disk under the filename "phonelog.txt". That file will be created in the same directory as the QBasic program. Each time the Phone Troll program is started, any additional entries will be added to the end of that text file. Since it is a simple text file, any convenient text editor in either DOS or Windows can be used to view and print the log. The file can be renamed to save it, or it can be deleted. In either case, a new file will be created and the logging started fresh.

An example log file is shown in Listing 1. The appearance is the same on screen and when saved to disk. The first time the program is run, the starting date and time are recorded. After that, just the time is recorded until midnight. At that point, the next record will be preceded by the new date.

In the example, we can see that according to the records, a telephone went "off-hook" (picked up) and a telephone number was dialed at 2:43 PM (which appears as 14:43 as all times are recorded in the 24-hour format). The call lasted about ten minutes.

LISTING 1

Phone log starting 08-16-1997 14:40:57

14:43:08	Off-Hook, DTMF active 7722076
14:53:13	On-Hook - call terminated
16:52:57	Ring - 3 not answered.
17:05:12	Ring - 2 not answered.
17:15:31	Ring - 2 not answered.
17:22:44	Ring - 1 answered. DTMF active - #81#80
17:27:09	On-Hook - call terminated
19:54:39	Off-Hook, DTMF active - #21
19:54:41	On-Hook - call terminated
19:55:53	Off-Hook, DTMF active - #31
19:55:55	On-Hook - call terminated
19:59:18	Off-Hook, DTMF active - #30#20
19:59:22	On-Hook - call terminated

The next three records show that the telephone rang. Both the time of the incoming calls and how many times each call rang are listed. Since the telephone never went "off-hook", the calls were listed as "not answered".

Next, the telephone rang once, was answered, and a control code of #81 was entered, activating the device that is connected to data line 8 on the printer port—let's say that it is a tape recorder whose microphone is connected to the telephone line. Before the call was terminated, control code #80 turned the tape recorder off. That could have been done from any telephone that is monitored by the Phone Troll and not just the one that was picked up for the call. An arrangement like that can be a handy substitute for pencil and paper when a message or important information needs to be saved.

The final three entries are additional demonstrations of controlling devices connected to the computer's printer port from a telephone. First, a lamp connected to bit 2 was turned on. Minutes later, another call turned on the home stereo con-

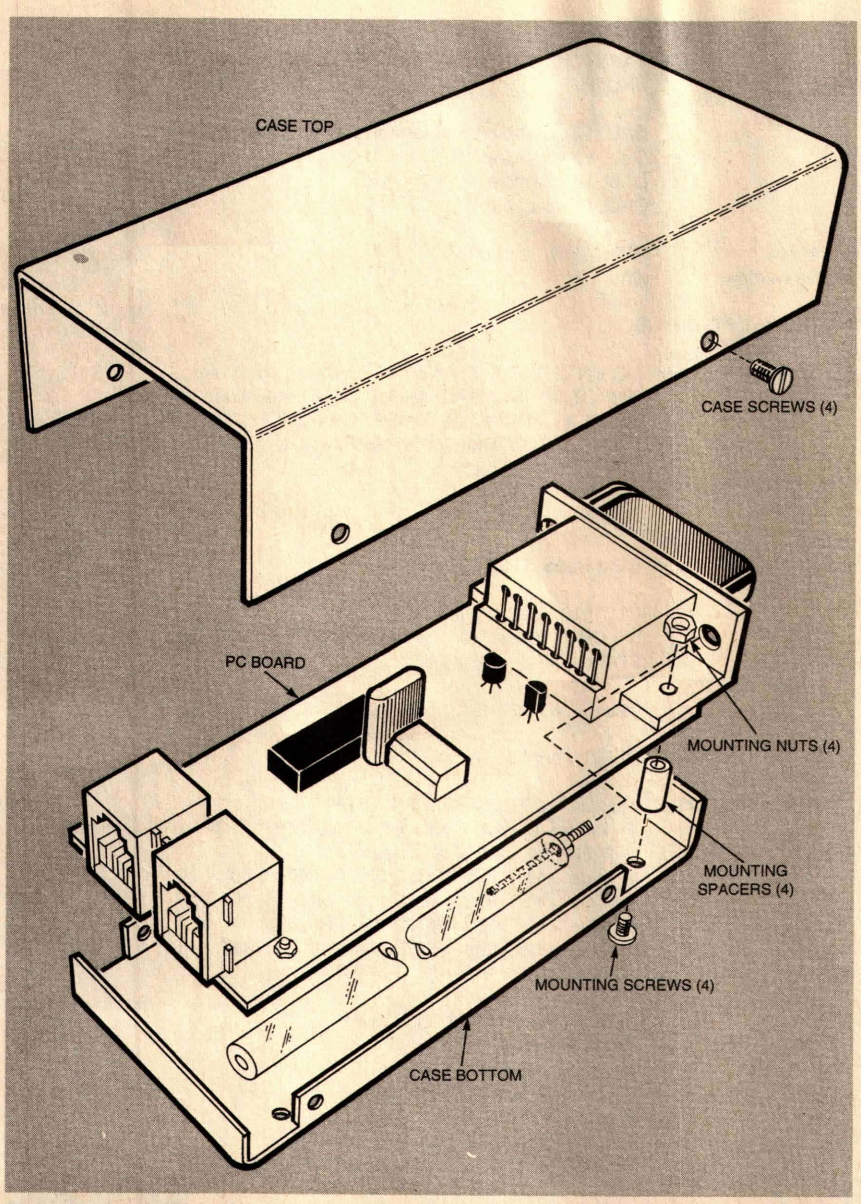


Fig. 4. Placing the Phone Troll in a compact case lets the unit attach directly to the game port on a computer.

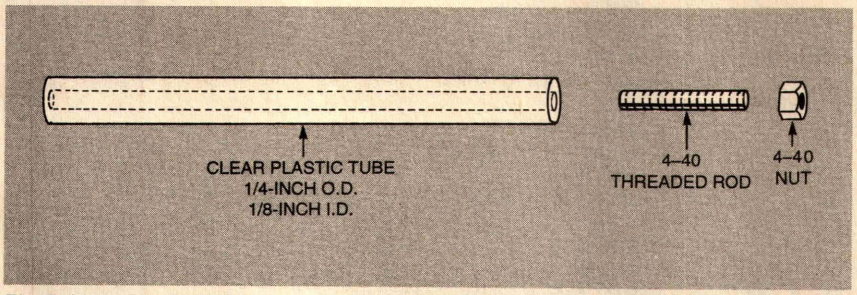


Fig. 5. The special hold-down screws for the Phone Troll are easily made from a piece of plastic tube and a length of threaded rod. You can easily make the threaded rod by cutting off the head from a 4-40 screw.

nected to bit 3. Several minutes later, the final call turned off both the stereo and the light in that order. Understand that any device that can be interfaced to a data line on a printer port can be controlled—lights, heat, air conditioning, or any other device that you can devise a control method for.

Circuit Description. The schematic diagram shown in Fig. 1 reveals how simple the Phone Troll's interface circuit is. Power for the circuit is supplied from the host computer's 5-volt supply through pins 1, 8, 9, and 15 of the game port. Ground is supplied from pins 4 and 12. Telephone jack J1 connects to the telephone line and is surge protected with MOV1. The other telephone jack, J2, is the jack through which the Phone Troll can monitor telephone activity. Any telephones connected to the J1 side of the telephone-wiring system will not activate the Phone Troll. Because of that, the Phone Troll will work best when connected between the telephone company and the telephones in the house—much like connecting additional telephone-line devices to the pass-through connector on a modem, fax machine, or answering machine.

Current on the telephone line is sensed by opto-isolator IC1. Two identical circuits within IC1 sense the current flow depending on the direction that it is flowing. Current flow in one direction will pass through R2 and pins 3 and 4 of IC1 while current flow in the other direction will pass through R1 and pins 1 and 2 of IC1. A wide range of DC current can flow from the telephone's central office, so diodes D1—D4 regulate the current through IC1. The small-signal audio impedance through the diodes and IC1 is matched by R3.

By monitoring the current and its direction, normal telephone activity can be determined. When current flows steady in one direction, the telephone has gone "off hook". On the other hand, current flowing rapidly in both directions means that the telephone is ringing. Typically, the "off hook" pattern is one of current flowing for ½ second in one direction, then switching to the other direction for the remainder of the call.

The second part of the Phone Troll circuit is the DTMF sensing and decoding. DTMF signals fit within the telephone band of 300 to 3000 Hz. Further information on DTMF signals can be found on the Web at http://www.2xtreme.net/dage/dtmf_tut.html.

The DTMF receiver (IC2) is made by Teltone Corp. That chip makes

LISTING 2

```
REM Release version 1.00 Date 10/16/97
REM No global variables, auto detection of output plug

DECLARE SUB OneSecTD ()
DECLARE SUB FindPort ()
DECLARE SUB LineSample ()
DECLARE SUB Ring ()

REM ratio = time current flows in one direction, divided by
REM time current flows in other direction during sample window.

REM The DATA below are the normal addresses for LPT1 to LPT3 in
    decimal.
REM Add additional output port (in decimal) to DATA, ending with 0 only.
REM "SUB FindPort ()" will read DATA below
DATA 888,632,956,0

CLS
CALL OneSecTD ' initialize
REM BEEP
REM PRINT "OneSec = "; OneSec; " FOR/NEXT loops"
REM FOR t = 1 TO OneSec: NEXT t ' wait one second
CLS
CALL FindPort

CLS

RecordDate$ = DATE$

OPEN "PHONELOG.TXT" FOR APPEND AS #1

PRINT #1, "Phone log starting "; RecordDate$, TIME$: PRINT #1, :
PRINT #1,
PRINT "Phone log starting "; RecordDate$, TIME$: PRINT : PRINT
CLOSE #1

inactive: '////////// START LINE MONITORING //////////

ringct = 0: noanswer = 0: incoming = 0      'initialize

DO
CALL LineSample
LOOP WHILE ratio = 9 'no current, ratio =9


CALL LineSample 'get fresh reading
IF ratio = 9 THEN GOTO inactive 'glitch remover

REM Phone line now active - either off-hook or ring

OPEN "PHONELOG.TXT" FOR APPEND AS #1

IF RecordDate$ <> DATE$ THEN 'Prints date once each day.
 RecordDate$ = DATE$
 PRINT #1, "Phone log for", RecordDate$: PRINT #1, : PRINT #1,
 PRINT "Phone log for", RecordDate$: PRINT : PRINT
END IF

PRINT #1, TIME$,
PRINT TIME$,

IF ratio > .5 THEN incoming = 1: CALL Ring

CallHandeling:

IF incoming = 0 THEN
 PRINT #1, "Off-Hook, DTMF active - ";
 PRINT "Off-Hook, DTMF active - "; 'DTMF digits displayed here
 ELSEIF noanswer THEN
 PRINT #1, "Ring - "; ringct; " not answered."
 PRINT #1, : CLOSE #1
 PRINT "Ring - "; ringct; " not answered.": PRINT : GOTO inactive
 ELSE
 PRINT #1, "Ring - "; ringct; " answered. DTMF active - ";
 PRINT "Ring - "; ringct; " answered. DTMF active - ";
 END IF

 CALL LineSample 'used for delay when phone lines switch
 CALL LineSample
 CALL LineSample
 CALL LineSample

 REM ////////// start DTMF //////////
 dtmf:

 DO

 DO UNTIL INP(513) AND 128 'loops until next digit
 IF (NOT INP(513) AND 48) = 0 THEN 'exits when on-hook
 PRINT #1, : PRINT #1, TIME$, "On-Hook - call terminated": PRINT #1,
 PRINT : PRINT TIME$, "On-Hook - call terminated": CLOSE #1
 PRINT : GOTO inactive
 END IF
 LOOP

 REM Read DTMF

 OUT 513, 0 'start one-shots
 n = INT(OneSec * .01) 'wait 10 mSEC
 FOR t = 1 TO n: NEXT t

 value = NOT INP(513) AND 15

 REM //// print all 16 valid DTMF codes ////

 IF value = 0 THEN PRINT "D"; : PRINT #1, "D";
 IF (value > 0) AND (value < 10) THEN PRINT CHR$(48 + value); :
    PRINT #1, CHR$(48 + value);
 IF value = 10 THEN PRINT "0"; : PRINT #1, "0";
 IF value = 11 THEN PRINT "*"; : PRINT #1, "*";
 IF value = 12 THEN PRINT "#"; : PRINT #1, "#";
 IF value > 12 THEN PRINT CHR$(52 + value); : PRINT #1, CHR$(52 +
    value);

 REM //// Start Control Application ////
 IF bas% THEN
 contdig = value
 IF contdig = 10 THEN contdig = 0
 IF cont = 1 THEN s = s + 1
 IF s = 1 THEN addr = contdig
 IF s = 2 THEN dta = contdig: s = 0: cont = 0: doit = 1

 IF contdig = 12 THEN cont = 1

 IF doit = 1 THEN
 op = 2 ^ (addr - 1)
 IF dta = 1 THEN
 outreg = outreg OR op
 ELSE
 op = op XOR 255
 outreg = outreg AND op
 END IF
 OUT (bas%), outreg
 doit = 0
 END IF
 END IF
 REM //// End Control Application ////

 DO WHILE INP(513) AND 128 'loops until digit gone
 IF (NOT INP(513) AND 48) = 0 THEN 'exit when on-hook
 PRINT #1, : PRINT #1, TIME$, "On-Hook - call terminated": CLOSE #1
 PRINT : PRINT TIME$, "On-Hook - call terminated"
 PRINT : GOTO inactive
 END IF
 LOOP
LOOP

END
```

designing a DTMF-receiver circuit very simple because all of the processing is performed on-chip. All that is needed for operation is a power supply, the audio signal, a timing crystal, and adjusting the guard time.

An AC-balance connection is made to the telephone line through C5 and C6. Precision resistors R8–R12 provide the balance network to IC2—it is important to balance both sides of the telephone line with respect to the op-amp portion of IC2. A 3.579545-MHz color-burst crystal, XTAL1, is directly connected to pins 7 and 8 of IC2. All of the necessary drive circuitry is internal with no external components needed. The guard time is set by R13 and C4. The values listed set the valid length for the "tone-present" and "tone-absent" timing to 40 ms. Those values should work perfectly; they can be adjusted if needed.

When a valid tone pair has been detected, the four-bit binary code that represents that tone pair appears on output pins 11–14. Pin 15 also goes high for 40 ms as a signal that the data on the output lines is valid and stable. That feature is very important in order to be able to use the game port in such a nontraditional manner.

An IBM game port has 8 inputs—

LISTING 3

```
SUB FindPort
SHARED OneSec
SHARED bas%

READ bs

DO
 test1 = 0: test2 = 0
 OUT (bs + 2), 4
 IF INP(bs + 1) AND 8 = 8 THEN test1 = 1
 OUT (bs + 2), 6
 IF NOT INP(bs + 1) AND 8 THEN test2 = 1
 IF test1 AND test2 THEN bas% = bs
 READ bs
LOOP WHILE bs

IF bas% = 0 THEN
 BEEP: PRINT "Test plug not found. Press  any key to enter address,"
 PRINT "or, wait for program to start without the control function.": PRINT : PRINT
 REM loop is about three times as long as  OneSec
 DO WHILE INKEY$ = "" AND t < 3 * OneSec
 t = t + 1
 LOOP
 IF t < 3 * OneSec THEN
 INPUT "Enter output port address in decimal."; bas%
 ELSE EXIT SUB
 END IF

ELSE PRINT "Base address = ";
HEX$(bas%); " HEX, or decimal"; bas%

REM Cycle output LEDs
 FOR n = 1 TO 3
 OUT bas%, 255: BEEP: FOR t = 1 TO OneSec / 5: NEXT t
 OUT bas%, 0: FOR t = 1 TO OneSec / 10:
NEXT t
 NEXT n
END IF

END SUB
```

LISTING 4

```
SUB LineSample
SHARED ratio

la = 0: lb = 0: LoopStartTime = TIMER
DO WHILE (TIMER - LoopStartTime < .2)
 IF NOT INP(513) AND 16 THEN la = la + 1 'check bit 4, active low
 IF NOT INP(513) AND 32 THEN lb = lb + 1 'check bit 5, active low
 REM correct LoopStartTime when passing thru midnight
 IF (TIMER - LoopStartTime < 0) THEN LoopStartTime = LoopStartTime - 86400
LOOP

IF la = 0 AND lb = 0 THEN 'Ideal samples
 ratio = 9 ' ratio = 9 Assigned; Line is calm
 ELSEIF la < lb THEN ' ratio = 1 Active Ring
 ratio = la / lb ' ratio = 0 Off-Hook
 ELSE ratio = lb / la
END IF

END SUB
```

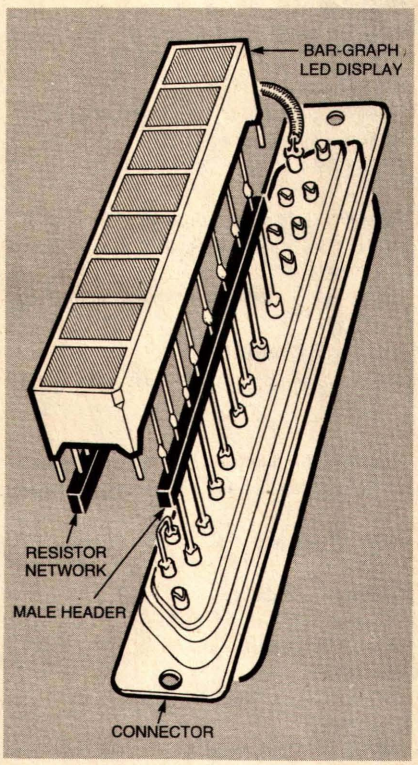


Fig. 6. The finished test fixture will look something like this. A straight-pin header helps connect the bar-graph display to the connector. The pins on the header will have to be spread to match the spacing on the header.

4 analog and 4 digital. Three of the digital inputs are used—two for the telephone-current sensing, and one for the "DTMF valid" signal. The data lines from IC2 are connected to the analog inputs. Here is where the "non-traditional use" comes into play. The DTMF data signals are connected to an individual resistor/capacitor circuit in the game card hardware that is used to control the pulse width of a one-shot multivibrator. If the digital signal is high, the one-shot times out fast; if the digital signal is low, the one-shot takes a long time to time out (if at all).

Since the DTMF signals are locked for at least 40 ms, that leaves enough time for the QBasic program to check the "joystick button" that indicates that DTMF data is available. The program reads the analog "joystick position" by triggering all four multivibrators. After a certain amount of time, the state of the one-shots are read out. The time period between triggering the one-shots and reading their state is long enough to give them time to time out if they are sensing a high signal, but not long enough to let them time out if they are sensing a low signal. Although it sounds complex and exacting in terms of critically-timed events, there is a wide margin available, making the readings very reliable. The QBasic program can accomplish those steps with time to spare.

Output Test Fixture. As mentioned before, the Phone Troll can control devices attached to the printer port. While the actual interface circuits are beyond the scope of this article, some way is needed to verify that the Phone Troll can actually send signals to the printer port. A simple test fixture is shown in Fig. 2. It is simply a set of 8 light-emitting diodes connected to the data lines of the port. A set of resistors limit the current through the LEDs, and the circuit is completed through the port's ground lines. With that arrangement, the LEDs can be lit individually with the control codes.

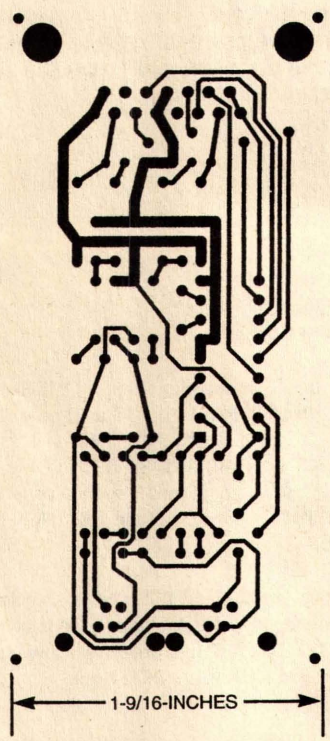
Lighting LEDs might not sound very exciting, but the LEDs can be replaced with any type of opto-isolator chip. Those chips can have different types of circuits on their output sides. Readily-available outputs include bi-polar transistors, silicon-controlled rectifiers, and Triacs.

LISTING 5

```
SUB OneSecTD
SHARED OneSec

REM Purpose:
REM To find the number of FOR/NEXT loops on a specific computer to cause
REM a one second delay, variable [OneSec] is number of loops/second.

REM Use:
REM For program delays > 3 mSEC to < 500 mSEC. Interrupts affect accuracy.

REM Example:
REM To delay 250 mSEC, insert this code:
REM n = INT(OneSec * .25)
REM FOR t = 1 to n : NEXT t

REM **** Calibrate host cmptr / Turbo must remain constant ****
PRINT "Calibrating FOR/NEXT delay loops. Please wait."
x = TIMER
DO WHILE x = TIMER: LOOP 'Wait until new clk tick
x = TIMER
 DO UNTIL TIMER - x >= .5
 n = n + 1 'see how many n's for half second
 LOOP

REM n is the number of do/loops in half sec. estimate for/next is 6X faster
n = n * 24 'should be close to 2 second delay

REM **** test and trim n for a 2 sec delay ****

lastloop = 2 'initialize
DO
 n = n * 2 / lastloop
 x = TIMER
 DO WHILE x = TIMER: LOOP
 x = TIMER
 FOR t = 1 TO n: NEXT t
 lastloop = TIMER - x
LOOP WHILE lastloop < 1.9 OR lastloop > 2.1
OneSec = INT(n / 2)

END SUB
```

Construction. The Phone Troll is a simple project to build. All of the components are mounted on a single-sided PC board. A foil pattern has been included for those who wish to etch their own board. As an alternative, a kit with a pre-etched board is available from the source given in the Parts List.

If you are building the kit or using



Here's the foil pattern for the Phone Troll.

LISTING 6

```
SUB Ring
SHARED ratio
SHARED ringct
SHARED noanswer

RINGADING:

DO
 CALL LineSample
LOOP UNTIL ratio < .5 OR ratio = 9 'loops while ringing, but may catch first silence

ringct = ringct + 1
CALL LineSample 'get full sample

REM ring has either stopped (ratio = 9) or phone goes off-hook (ratio < .5)
REM assume between rings, then check for off-hook

RingStartTime = TIMER

DO WHILE TIMER - RingStartTime < 5  AND ratio = 9
 CALL LineSample
 REM correct RingStartTime when passing thru midnight
 IF TIMER - RingStartTime < 0 THEN RingStartTime = RingStartTime - 86400
LOOP

CALL LineSample

IF ratio > .5 AND ratio <> 9 THEN GOTO RINGADING 'ring again
IF TIMER - RingStartTime >= 5 THEN noanswer = 1

END SUB
```

the included foil pattern, use the parts-placement diagram in Fig. 3 for locating the various components. Note that two jumper wires are needed; they are located near P1. When mounting the components, pay careful attention to the orientation of the semiconductors. The 1% resistors have three digit bands instead of two. The values, however, can still be read using the standard color codes.

The assembled board can be enclosed in a suitable case and mounted to the game port as shown in Fig. 4. With that arrangement, you will need to make a pair of extended screws for securing the Phone Troll to the game-port connector. Take a suitable length of stiff plastic pipe that is hollow. Glue a length of 4-40 threaded rod in one end so that it sticks out enough to screw down P1 to the game port. A nut should be threaded onto the rod to act as a stop. The length of the plastic pipe should be long enough to reach out the back of the case. That way, the screw can easily be turned by hand. The details for the extended screw are shown in Fig. 5. If you do not want to mount the Phone Troll like that, you can install it in a receptacle box and connect it to the game port with a cable and 15-pin "D" connector.

The test fixture can be made from an eight-LED bar-graph display, a single-inline resistor network, a 25-pin connector, and a strip of single-row straight header. The header will need to be bent on one side to match the spacing of the connector. That method makes a rugged assembly that matches up the different pin spacings between the connector and the bar-graph display.

Don't forget to install a jumper between pins 14 and 15 on the connector. The QBasic program will check all of the available parallel ports. The jumper will help identify the connector to the program. The completed fixture will look similar to the one shown in Fig. 6. As a side note, the test fixture can also be used as a stand-alone test tool. You can use it to automatically find, identify, and test an active parallel port including enhanced parallel ports.

Testing the Phone Troll. Connect the telephone lines to the Phone Troll and attach it to the PC's game port. Plug the test fixture into the printer port. The QBasic program will have to be typed in—follow Listing 2 through Listing 6 in order. Save the program as "FONETROL.BAS". Run the program, and the Phone Troll is up and running. If you aren't using the test fixture, the program will pause to let you set the parallel-port address. If no address is entered, the program will continue but without the control function.

After the program checks your computer's speed (for the timing function) and determines which parallel port is active, it will display the date, time, and start a log file. Pick up a telephone and the screen should show "Off-Hook, DTMF active". Press #11 through #81 and all eight LEDs should turn on one at a time, depending on which LED you're activating. Press #10 through #80 and all eight LEDs should turn off.

When building a new device, there's always the possibility that it won't work the first time. Recheck all of the parts for correct placement, orientation, and solder connections before continuing. Troubleshooting is more of an art form than a science and can't easily be explained in a few paragraphs. However, here are a few test points to check that will help isolate any trouble spots in the circuit. When the telephone goes off-hook, the voltage at R7 (next to Q2), or voltage at R5 (next to Q1) will drop from 5 volts to less than 1 volt. With a high-impedance device such as an oscilloscope or logic probe, verify that the oscillator at pin 8 on IC2 is running. Pick up a telephone that is being monitored by the Phone Troll and press a button. You should see that pin 15 on IC2 pulses low. Those tests will help pinpoint any spots in either the circuit or the software for additional tests.

Programming in QBasic. A nice feature with QBasic is that you are not restricted to the original program as would be the case with a compiled executable program. Running the Phone Troll directly from the source code lets you customize the Phone Troll's features to your own wants, needs, and desires. You will still need

to know how to program in QBasic, but it's very easy to modify the code and see what happens. Many budding programmers start gaining hands-on experience by modifying a program to achieve a particular goal. Just make sure that you have a backup copy of the program before you start experimenting. The program is well documented and will stand alone to act as a guide for those who are familiar with QBasic.

One example of a need to modify the program has to do with distinctive-ring service. The program will detect and count a normal ring cycle (two seconds of ringing followed by four seconds silence). Distinctive ringing might cause the Phone Troll to count each burst of rings, indicating two or three rings for each actual ring. Simply divide the variable *ringct* by two or three, or rewrite the program to indicate which sequence of rings was received.

Like any good servant, your troll awaits. Ω

HEAT DETECTOR

(continued from page 41)

Using the Heat Detector. There are a few points to consider whenever using the Heat Detector to obtain consistent readings: always grasp the unit by the handle only, keeping your body heat as far away from the cabinet as possible. For critical operation, attaching the unit to a camera tripod would be an excellent method.

Unless you are actually leak-testing and looking for circulating air, any air that blows across Q1 will cause temperature drift in your readings. Still air is the priority here.

The parabolic reflector used is very directional and will take some practice in aiming. Pointing a standard flashlight at an opposite wall will give you an idea of the area of coverage to be expected.

Hold the unit by the handle and set R3 to its *minimum* gain setting. Set R7 and R9 to their mid-positions. Turn on the power and point the reflector at a blank wall.

Adjust R7 for a display of about half of full scale on M1. That is the most sensitive area, although any region between 20% and 80% will work well. If R7 won't get you on scale, it might be necessary to adjust R6's value. An increase in value lowers M1's reading, and vice versa.

Advance R3 slowly while watching the display—it will probably move off-scale in one direction or the other as you arrive at the maximum gain setting. That is due to inherent offset voltages in the components. Adjusting R7 should give full-scale coverage in either direction at the highest gain setting. If not, adjust R6's value as mentioned above.

Note that making any settings with R7 becomes more difficult as the gain is increased. That is where R9 becomes very useful. For best results, always adjust R7 first to get as close as possible; then use R9 as a "fine" adjust for a 50% of full-scale indication on M1.

Set R3 back down to its minimum gain setting and adjust R7 for a 50% reading on M1. Now that you have an ambient-temperature set-point from the blank wall, point the unit at a match or candle flame about 6 to 12 inches away. You should immediately "peg" M1. Return to the blank wall and the display will return to 50%.

Rotate R3 to mid-position, and adjust R7 for a 50% reading on the blank wall. Hold the palm of your hand about 6 to 12 inches in front of the reflector and M1 should go full-scale again. Hold an ice cube in front of the reflector and M1 should drop to its minimum reading.

Rotate R3 to its maximum position, and adjust R7 (followed by R9) for a 50% reading on the blank wall. Now you can "sweep" slowly around the room. A hot spot such as a sun-lit window or a lamp will probably peg M1 at full-scale. You will now note that any breeze, even one caused by rapid movement of the Heat Detector, will cause display drift!

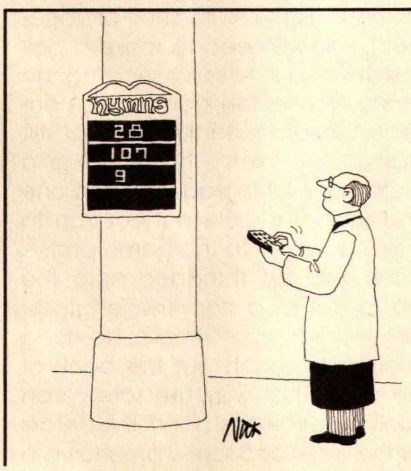
Going Further. You will by now have realized that the parabolic reflector plays a critical role in the sensitivity and area of coverage of the Heat Detector. A 3-inch-diameter reflector is an excellent size for general-purpose use. However, it can be difficult to aim accurately at distant objects.

The solution to that problem is to use a larger reflector. Any photographic supply store will carry larger-diameter reflectors. Of course, the sensitivity of the instrument increases with the square of the diameter in addition to the coverage.

Some applications such as remote testing of circuit boards for hot spots might have the opposite requirement—miniature parabolic reflectors. A 1-inch-diameter reflector would be highly directional. The Heat Detector has sufficient gain to compensate for the decreased gain from the reflector. A miniature flashlight would be a good source for smaller reflectors.

Of course, you still have to make sure that Q1 is focused properly. An adjustable focus arrangement would be a great help in close-up work, where the focal point moves further away from the rear of the reflector. One method that can be used to make the Heat Detector more versatile would be to use a TO-5 transistor socket with female pins that are spring-loaded and completely hollow through their length. That would allow you to slide Q1 back and forth to achieve any focus position.

The Heat Detector is an easy-to-build precision instrument that shouldn't cost more than about $25 to put together even using all new parts. Any salvaged or surplus components will drop the cost of the project to the point where it becomes an almost trivial matter to add such an instrument to your bench or tool kit. Build one yourself and have hours of educational fun, or even put it to some practical use! Ω



MAKE YOUR OWN SHUNTS!

While they might not be as accurate as the commercial units, these easy-to-make shunts are more than sufficient for many uses, and cost far less.

DEAN F. POETH II, Ph.D., K8TM

Using a modern multimeter to measure current can sometimes be difficult. Many of these meters will only measure up to one amp. However, many 12-volt DC-powered projects draw a lot more than that. If you have ever thought of purchasing a commercial shunt to solve the problem, you know just how expensive they can be. Commercial shunts, while very precise, frequently cost more than the projects they are measuring!

However, there is a better and cheaper alternative that will work perfectly well in most situations: With only a few cents worth of wire and a little know-how, you can make your own shunts. It only takes a few minutes, and it's fun!

What Is A Shunt? A shunt is simply a resistor of very low value (frequently less than one ohm) that is used to help measure current. As shown in Fig. 1, the shunt resistor R_{SH} is placed in parallel with a meter to decrease its sensitivity by a known amount. The shunt does that by bypassing or "shunting" most of the current around the meter. The shunt resistor therefore lets you take a standard meter, such as a 0–1 milliammeter, and turn it into, say, a 0- to 20-amp meter.

The Shunt Meter. Before you can make a shunt, you must find a suitable shunt meter. Surplus analog meters can be found at hamfests or mail-order sources for only a few dollars each, and they make excellent shunt meters. For a list of mail-order sources of surplus analog meters, as well as new ones, see the sidebar.

When selecting a meter, try to pick a 0–1 milliammeter in good physical condition and one with a convenient scale on the faceplate. For example, if you need the meter to read 10-amps full scale, then select a meter graduated from 0 to 1. If you need a full scale reading of 30 amps, select one with a 0 to 3 graduation.

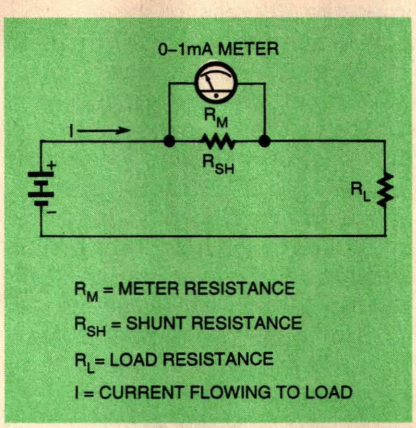


Fig. 1. A shunt is simply a resistor of very low value (frequently less than one ohm) that is used to help measure current. It is placed in parallel with a meter to decrease its sensitivity by a known amount.

To make a shunt, you will need to know the internal resistance of your meter. Therefore, select a unit that has its internal resistance printed on it, most likely in small letters on the meter face or on the back near the terminals.

If you already have a meter on hand but do not know its internal resistance, there is a simple way it can be determined. If you have a modern *digital* multimeter, set it to its highest resistance range. Connect the multimeter's red (positive) lead to the positive analog meter terminal and the black (common) lead to the analog meter's negative terminal.

Digital multimeters measure resistance by passing a small amount of current through the device under test. Do not attempt to use an *analog* multimeter to make this measurement. These older multimeters use much more current to test resistance, enough to potentially destroy some milliammeters

Watching your analog meter, work your way down the DMM's resistance ranges (remember you began at the highest range) until the analog meter's needle moves to a full-scale reading. Note the reading on your DMM, and write it on the back of the meter using a permanent marker. Be careful and take your time. If you go too fast and accidentally pin the meter, it could easily be damaged.

Making The Shunt. The shunt is made from a short length of copper wire. All wire has resistance, so we can use that property to make a shunt resistor. To make the shunt, you first need to determine how much current will flow through it. For example, if your meter is going to measure 20 amps full scale, then the shunt wire must be safely able to carry that amount of current.

Let's say you are going to make a 20-amp shunt using a surplus analog 0–1 milliammeter whose faceplate is graduated from 0–1. Go to a copper-wire table (there is one in the *ARRL Handbook for Radio Amateurs*; if you don't have a copy, it is available at almost any public library) and select an appropriate gauge wire. Remember that the smaller the wire gauge, the larger its diameter and the more current it can safely carry. For most hobby applications, 250 circular mils per amp is more than adequate.

To find the circular mils per amp for the shunt wire, divide the circular mils for the selected wire (found in the copper wire table) by the

Surplus and New Analog-Meter Suppliers

All Electronics Corp.
P.O. Box 567
Van Nuys, CA 91408-0567
Tel: 800-826-5432

Digi-Key Corp.
701 Brooks Ave. South
P.O. Box 677
Thief River Falls, MN 56701-0677
Tel: 800-344-4539

Fair Radio Sales Co.
P.O. Box 1105
1016 E. Eureka St.
Lima, OH 45802
Tel: 419-223-2196

Mouser Electronics
2401 Highway 287 North
Mansfield, TX 76063-4827
Tel: 800-346-6873

RadioShack
Stores nationwide

The Electronic Gold Mine
P.O. Box 5408
Scottsdale, AZ 85261
Tel: 602-451-7454

current you intend to pass through the wire:

Circular Mils per amp = (circular mils for wire)/(current through the wire) (Eq. 1)

By using the copper wire table, you will find that 12-gauge wire has a cross-sectional area of 6530 circular mils. By dividing that by 20 amps, we get 326 circular mils/amp, which should work fine. Twelve-gauge wire is very common, and can be purchased in most hardware stores.

To find the resistance of the shunt, use this equation:

$$R_{SH} = R_M / (n-1) \quad \text{(Eq. 2)}$$

Where R_{SH} is the resistance of the shunt, R_M is the resistance of the surplus meter, and n is the shunt's multiplication factor. In our example, since we are using a 0–1 milliammeter and 1 milliamp = 0.001 amps, n = 20 amps/0.001 amps, or 20,000.

Next, let's suppose that the resistance of your meter was 81 ohms. Plugging that resistance and n = 20,0000 into Equation 2 yields:

$$R_{SH} = 81V/(20{,}000\text{-}1) = 0.00405V$$

That's not very much resistance, is it! A shunt having that resistance will pass 19.999 amps thought it, and 0.001 amps (1 mA) will pass through the meter for a full-scale reading.

Next, we need to calculate the length of our shunt. Note that as stated in the copper-wire table, 12-gauge wire has a resistance of 1.619 ohms/1000 ft. Therefore, the length of the shunt wire (L_S) can therefore be determined using:

$$L_S = R_{SH}/(XV/1000\ \text{ft.}) = 0.00405/(1.619V/1000\ \text{ft.}) = 2.5\ \text{ft.}$$

So the 12-gauge wire shunt should be 2 feet 6 inches long when using a 0–1 mA meter having an internal resistance of 81 ohms to measure 20 amps full scale.

If we made the shunt this long, however, we might have trouble with contact resistance. That is because even a good solder joint has a lot of resistance when compared to a 0.00405-ohm shunt. To make sure that the circuit's contact resistance is not part of the shunt resistance, two *sense* wires are used. These sense wires are spaced L_S apart on the shunt wire as shown in Fig. 2. Any type of wire may be used for the sense wires; they are noncritical. This simple feature will greatly increase the accuracy of your shunt.

Now we are ready to make our shunt. Cut a length of 12-gauge solid copper wire about 3-feet long. Remove the insulation from the wire using a hobby knife, being careful not to nick it. Now measure about 2 inches from one end and solder one sense wire there. Carefully measure 2 ft 6 inches from that sense wire and solder the second sense wire in position. Connect the shunt to its meter as shown in Fig. 2, and you're ready to measure current! If you want to make the shunt a little more compact, you can wind it over an insulated screwdriver handle or something similar such as a non-conductive wood dowel.

Calibrating the Shunt. Shunts made using this method can be very accurate. However, improved accuracy can be achieved by calibrating the shunt to a known standard, *i.e.*, a calibrated meter. To do this, build the circuit shown in Fig. 3. Make sure that the load resistance, R_L can safely handle the power. I have found that car taillight lamps make a convenient load for the circuit.

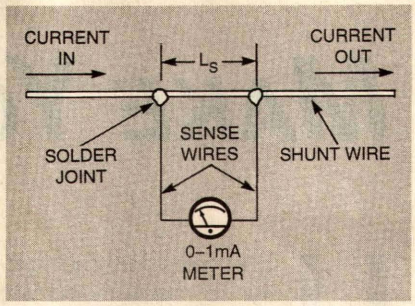


Fig. 2. Two sense wires can be used to make sure that the circuit's contact resistance is not part of the shunt resistance.

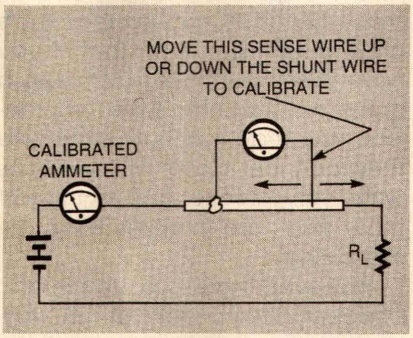
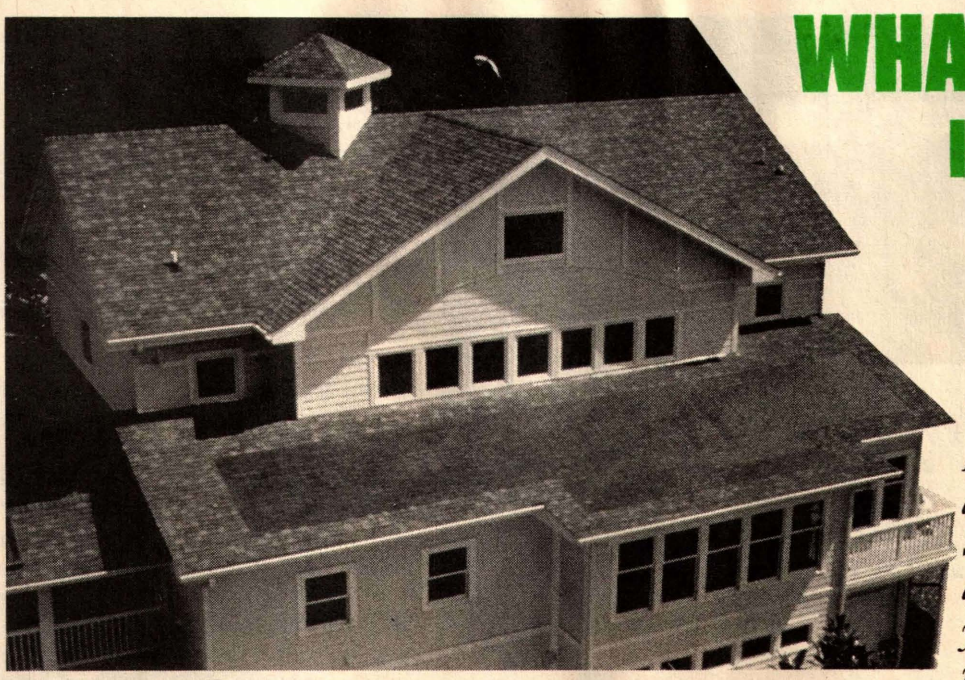


Fig. 3. To make sure that your shunt is as accurate as possible, this setup can be used. An automobile taillight lamp is a good candidate for the load resistance.

To calibrate the shunt, solder one sense wire into position as described above. Power up the circuit and slide the second sense wire up and down the shunt wire until you find the spot where the shunt meter reads the same current as the calibrated meter. Remove power from the circuit and solder the second sense wire at that spot.

Conclusion. Using these methods you can make shunts for almost any range of DC currents. What's more, with a little care you should be able to make shunts accurate to within 5–10% if you keep them near room temperature. Of course, these shunts are not nearly as precise or temperature-stable as the commercial versions. Still, if you need one for a non-demanding application, or just want to have some fun, grab a few cents worth of wire and make your own shunt! Ω



WHAT'S NEW IN SOLAR POWER

"Building-Integrated Photovoltaic" Systems and the "Million Solar-Roof Initiative" are two reasons why your next home might be powered by the Sun.

BILL SIURU

Many homeowners have thought about going to solar power, but up to now might have been turned off by the hassles of a typical solar-panel array installation. Besides being quite costly, in most cases solar systems have been downright ugly. Indeed, some communities even have covenants against their use.

Fortunately, that is changing as photovoltaic suppliers, working with architects and builders, are developing "Building-Integrated Photovoltaic (BIPV)" systems. That has resulted in residential solar electric systems with greatly improved aesthetics—those BIPV systems are an integral part of the home design rather than an obvious and often unattractive add-on.

The new BIPV systems do double duty. They convert sunlight into electricity while performing the traditional jobs of roofing materials—protecting the structure from the elements while enhancing its appearance. Two examples of the new product are United Solar's Uni-Solar PV Shingles and Atlantis System's SunSlate Roofing System.

But there's more happening on the solar-energy front than just products that look much better. The cost of home photovoltaics has also come down, with even more reductions promised for the future. With ever improving technology, the cost of generating electricity using photovoltaics, now at 25 to 50 cents per kilowatt-hour, may go as low as 12 to 16 cents per kilowatt-hour. Looking at it in another way, photovoltaic modules that sold for $50 per rated watt of peak generating capacity in 1970 dollars, now sell for $5 to $7 per watt.

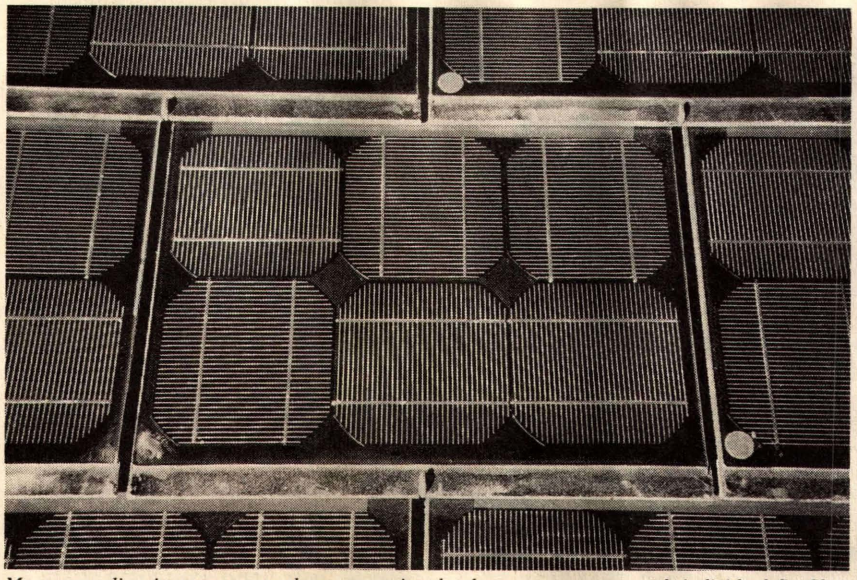
Solar Shingles. United Solar, a joint venture between Energy Conversion Devices, Inc. and Canon Inc., a leading international manufacturer of office equipment and photographic and optical products, is now offering a line of solar shingles for residential applications as well other innovative solar metal-roofing products for commercial buildings.

The flexible shingles use propriety thin-film semiconductor materials for the solar cells. Made of stainless steel coated with silicon semiconductor material and plastic, the solar shingles look like ordinary asphalt ones. The system integrates the solar shingle with the necessary "combiner" boxes, inverter, and wiring to convert sunlight into electric energy and distribute it directly to the building.

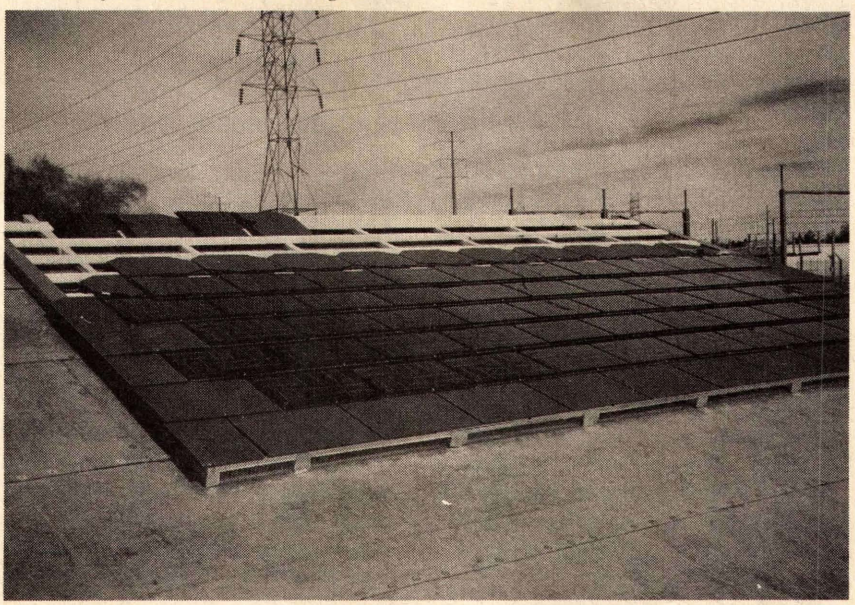
The Uni-Solar PV Shingles use amorphous silicon in thin films as the light-to-energy conversion material. While amorphous silicon has a lower conversion efficiency than the more traditional crystalline silicon, it potentially has a lower mass-production cost. Therefore, it is often seen as the best option for cost-effective home photovoltaic systems. What's more, recent advances have closed the gap between the two technologies. In particular, United Solar, under U.S. Department of Energy funding, has developed a thin-film amorphous-silicon cell that converts over 10% of sunlight into electricity, a significant improvement over the less than the 6% efficiency typical for this technology. That compares favorably to an efficiency of over 12% currently available from crystalline-silicon technology.

To achieve that efficiency, each cell in a Uni-Solar PV Shingle actually is made up of three separate p-i-n-type amorphous semiconductor solar sub-cells, each with a different spectral-response characteristic. That allows the cell to convert the different visible and near infrared wavelengths of sunlight with optimum efficiency.

United Solar and ECD have developed a low-cost manufacturing technique to make the thin-film amorphous-silicon alloy multi-junction solar modules. The pioneering technique uses one-half-mile-long substrates in a roll-to-roll process for manufacturing solar cells. The technique is similar to how newsprint



More appealing in appearance than conventional solar-power arrays, each individual SunSlate roofing tile, with a photovoltaic cell mounted on it, produces 12.5 watts. The tiles are nailed on to a structure just like conventional shingles



Part of a SunSlate-roofing-tile power array installed at the Arizona Public Service Company's STAR Center in Tempe, AZ. The complete system is rated at one kilowatt.

FOR MORE INFORMATION

United Solar Systems Inc.
1100 West Maple Road
Troy, MI 48084
Tel: 248-362-4170; Fax: 248-362-4942

Atlantis Systems, Inc.
233 S. Auburn, Suite 110
Colfax, CA 95713
Tel: 916-346-9595; Fax: 916-346-9795

and photographic film is produced. The production plant, which came on-line in March 1997, can manufacture enough solar panels to generate five-million watts of electrical energy annually.

The seven-foot-long Uni-Solar PV Shingles are installed just like regular shingles, and the job can be done by any roofer. The shingles are nailed onto the roof and the pair of wires attached to each shingle are inserted through holes in the wood decking. An electrician then connects the wires below the roof. A mixture of solar and ordinary shingles is used since, with sufficient sunlight, only one-third-of-a-roof's-worth of the shingles is needed to power the average home. The solar shingles blend in to the roofing pattern of the traditional asphalt shingles.

Uni-Solar PV Shingles have been installed on several demonstration homes. The Energy Efficient Home in Atlanta is fitted with a 2-kW solar-shingle array. Urban Options operates the Energy and Environmental Demonstration House in Lansing, MI, which features a 2-kW, 120 solar-shingle array. A 1.5-kW, 96-shingle system is installed at the University of Denver's astronomical observatory atop Mount Evans. That stand-alone system includes a DC-to-AC converter and 16 storage batteries that provide sufficient power to operate the lab's computers, instruments, and lights for up to five days. The Centex Home of the Future, built for the International Builder's Show in Dallas, uses an 800-watt, 200-square-foot Uni-Solar roof-shingle system that provides electricity for computers, security system, skylight-drive motor, garage-door opener, and two emergency service outlets. Operating independent of normal utility power, it provides both backup electricity during outages as well as saving on electrical-energy costs.

Atlantis Systems, Inc. is also offering aesthetically appealing BIPV capability with its SunSlate Roofing System. Each individual SunSlate roofing tile, with a photovoltaic cell mounted on it, produces 12.5 watts. The tiles are nailed on to a structure just like conventional shingles. The Sacramento Municipal Utility District (SMUD), along with Atlantis Systems, the Sacramento Housing and Redevelopment Agency, a local architectural firm, and a local construction company are installing SunSlate roofs on 20 new homes in a new 45-home subdivision in mid-town Sacramento. As part of SMUD's PV Pioneer II program, SMUD pays half of the costs of a new SunSlate system and is helping the new owner to obtain a reduced mortgage rate on the home. While the homeowner will be paying between $7,000 to $7,500 for a system, it will generate 75-85% of a home's electricity needs annually, meaning that the SunSlate system should pay for itself in about 12 years.

Recently ETA Engineering in Scottsdale, AZ installed an 80-SunSlate-roofing-tile array for Arizona Public Service Company at its STAR Center in Tempe, AZ. The total system

(Continued on page 62)

Alternate Power Sources for Cars, One-Chip Line-Powered Supplies, and More.

LET'S START THIS MONTH WITH A QUICK QUESTION: WHICH IS MORE EFFICIENT—A HEAT ENGINE OR A FUEL CELL? BEFORE YOU ANSWER, NOTE THAT THE FOLKS AT *POWER ENGINEERING* MAGAZINE REPORT THAT THE LATEST POWER PLANTS are approaching a stunning 60% thermal efficiency by using close-coupled multi-cycling. Also note that one power utility is extremely proud of its real world 50% electrical-efficiency fuel-cell installations.

As always, there will be intelligent choices and reasonable tradeoffs. And, as always, a good starting point should be accurate technical information from unbiased sources. Let's see where this leads us as we seek out some . . .

Transportation Alternatives

A personal-transportation vehicle consists largely of an energy carrier and an energy converter. Three valid measurements of the energy carrier are: "How heavy is it?" "How much room does it take up?" And "What is the total cost per mile?" Gasoline is your baseline energy carrier at 9000 watt-hours per liter and 13,500 watt-hours per kilogram. With a cost of roughly seven cents per mile for the consumables and 30 cents per mile for payments, taxes, and insurance.

These figures define the capability of the carrier itself. Such figures have to be adjusted downward when you factor in how efficiently your energy can be used and how much structure, containment, or whatever is needed to safely hold the carrier.

Naturally, any proposed alternates also must be adjusted downward as well. Figures must also be modified for the distortions caused by taxes or any hidden subsidies.

Because of thermodynamic laws, an ICE (Internal Combustion Engine) has to throw away a lot of heat in order to produce a little mechanical power. The best you can even hope to do is called the Carnot efficiency limit and is determined solely by the high-side and low-side temperatures. The typical automobile ICE-efficiency at the flywheel is around 30 percent.

The claims of "how much better" the alternatives might be are often outrageously overstated. For instance, a typical electric motor of suitable size and price probably provides an efficiency of no better than 90 percent. Its controller will be hard pressed to hit 85, and its wiring will be unable to exceed 98. Combine these for a realistic 75 percent efficiency. And, no, regenerative braking does not help nearly as much as some of its more-vocal proponents claim.

What if you add a fuel cell to the mix? It turns out that the best of hydrogen-electrolysis cells are one-sixth endothermic, so you'd pretty much expect the best fuel cell to end up as one-sixth exothermic, which means that 83 percent efficiency is the best you are likely to do. Combine fuel cells with electric motors, and you are down at a 63-percent efficiency limit. That's certainly better than gasoline engines, but not spectacularly so.

Here's how I see some of the key issues that seem to involve personal transportation alternatives:

Business as usual: A lot can still be done to tweak the performance of conventional ICEs. Examples include ceramic cylinders, six-cycle operation, ultra-lean combustion, modest hydrogen injection, valve timing done on-the-fly, improved turbocharging, adjustable compression, and possibly even a new bottoming cycle. A company by the name of Aurora Engineering has some exceptionally innovative new stuff in this area, including things like electrically actuated valves and combination starter-alternator-flywheel packages that even can double as AC power generators.

Turbines: Turbines provide high power in a small and lightweight package. They are superb for airplanes, but are grossly inefficient at less than full output and usually run only at extreme speeds. I'd expect this one to literally stay off the ground.

Liquefied natural gas: The energy

NEED HELP?

Phone or write all your US Tech Musings questions to:

Don Lancaster
Synergetics
Box 809-EN
Thatcher AZ, 85552
Tel: 520-428-4073

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LaserWriter Reference	$19.50
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HYBRID:

1994 Hybrid Electric Vehicle Challenge D. Stephens
Advanced Components for Electric and Hybrid Vehicles, EVIS
Advancements in Electric and Hybrid Vehicle Technology, SAE
Designing a Fuel Cell Hypercar, A. Lovins
Design Innovations in Electric and Hybrid Vehicles, B. Bates
Electric & Hybrid Vehicle Design Studies, SAE
Electric & Hybrid Vehicle Technology, N. Bagot
Electric & Hybrid Vehicles: Implementation of Technology, SAE
Hypercar Sampler, A. Lovins
Strategies in Electric and Hybrid Vehicle Design, B. Greene
Tools & Stratgies for Hybrid Electric Drivesystem Optimization, A. Lovins
Ultralight Hybrid Vehicles; Principles and Design, A. Lovins

OTHER:

Batteries and Fuel Cells for Electric Vehicles, Electrochem Society
Build Your Own Electric Vehicle, B. Brant
The Car That Could: The Story of GM's Electric Vehicle, M. Shnayerson
Convert It, M. Brown
Electric Vehicle Battery Systems, S. Dhameja
Electric Vehicles: A Decade of Transition, B. Bates
Electric Vehicles: Driving Towards Commercialization, R. Sims
Electric Vehicles: Technology, Performance, & Potential, IEA
The Ev Encyclopedia: A guide to Electric Vehicles, B. Batson
From Gasoline to Electric Power, G. Powers
Future Drive: Electric Vehicles & Sustainable Transportation, M. Delucchi
Green Cars: Earth-Friendly Electric Vehicles, J. Coughlan
History of the Electric Automobile: Battery-Only Powered Cars, E. Henry
The Keys to the Car: Electric & Hydrogen Vehicles, J. Mackenzie
Life With an Electric Car, N. Perrin
Near Term Electric Vehicle Costs, J. Sawin
The New Electric Vehicles, M. Hackleman
Solo: Life With an Electric Car, N. Perrin
The Lost Chord: The Story Tellers History of the Electric Car, B. Taylor
Taking Charge - The Electric Automobile in America, B. Schiffer

FIG. 1—SOME CURRENT BOOKS on hybrid and electric vehicles. More title information can be found at http://www.tinaja.com/amlink01.html.

density here is certainly useful, but still remains significantly less than gasoline. The same goes for propane. The popularity of this method waxes and wanes with the relative economics of oil versus gas, and it gets distorted by taxes, subsidies, and hidden agendas. Infrastructure is obviously limited. I don't see this option getting very far unless economics radically change.

Grain alcohol: When based upon an American-farm corn economy, a lot more energy will go into producing alcohol than you can ever hope to get back. From an energy standpoint, the process can be considered a giant funnel. You pour gasoline in the top and alcohol dribbles out the bottom. Further, alcohol additives appear to be causing far more problems than they solve. Yes, there is definitely a third-world subsistence potential by using bagasse (sugar cane residue) or similar feedstocks. Otherwise, this one makes no engineering sense whatsoever. At least not to me.

Steam engines: Believe it or not, the steam-powered automobile was done in by hoof-and-mouth disease. Seems they drained all those public horse troughs just as inferior gas engines were starting to discover production economics. A steam engine is vastly simpler, offers high power on every stroke, and needs neither a clutch nor a transmission. Key issues remain closed-cycle vapor re-condensation, corrosion or scaling problems, and any inefficient superheating techniques. This one still has lots of potential, but seems to lack a credible champion.

Pure electrics: The energy density of batteries is utterly abysmal when compared to gasoline—only 35 watt-hours per kilogram for lead-acid and ten times that for lithium. The range, weight, and charging infrastructure remain key problems. It also turns out that any battery

operates by knocking loose one single electron in its outer shell. So, the smaller the atom, the better the energy density. I see nothing ever beating out lithium (atomic number=3) for the ultimate energy density. A useful Web site on this topic can be found at www.evworld.com.

Because laptop computers are an instant and a billion-dollar market for improved battery technology, I'd expect the computer folks to inadvertently "solve" the electric-car problem, in spades. They clearly have the money and the motivation.

Fuel cells: The essential difference between a battery and a fuel cell is that the fuel cell continually receives external chemical energy from one or more product streams, often by using hydrogen and oxygen. The crucial advantage of a fuel cell is that it is not a heat engine and thus will not be Carnot limited at its best efficiency. Another major advantage is that its main waste product is water.

Central issues in fuel cells today involve the reforming of methane or gasoline to make useful feedstocks, and trying to get the efficiency and performance up and the costs down. Fuel cells are still not very efficient, nor all that great at any suddenly changing power levels. Ballard is one high-profile source. A leading Web site on this topic is www.fuelcells.org. A major technical publication is the *Hydrogen and Fuel Cell Letter*.

Hybrids: Any ICE run at a constant speed is easily optimized. Batteries aren't all that heavy if you don't use that many of them. In a serial hybrid, the engine drives a generator, which powers the motors, eliminating the drive train. In a parallel hybrid, both engine and electric motors can drive the wheels, and both can be one half of the needed peak power. I believe this one is by far the best near-term solution. Amory Lovins of the Rocky Mountain Institute is one champion of hybrid vehicles. Be sure to visit his site at www.rmi.org.

Hydrogen: The energy density by weight of hydrogen is outstanding—three times gasoline at 39,000 watt-hours per kilogram. Hydrogen routed to either an ICE or a fuel cell produces primarily water vapor as waste. Sadly, the energy density by volume as a gas is a pitifully absurd 3.5 watt-hours per STP liter. Even when liquefied, there is around four times less hydrogen in a gallon of liquid hydrogen than there is in a gallon of gasoline.

Alternative Automotive Resources

AEE Energy Books
PO Box 1026
Lilburn, GA 30226
(404) 925-9558

Aurora Engineering
4823 S Marine Avenue
Lawndale, CA 90260
(310) 675-0804

Automotive Industries
PO Box 2056
Radnor, PA 19080
(215) 964-4876

Ballard Power Systems
9000 Glenlyon Pkwy.
Burnaby, BC V5J 5J9
Canada
(604) 412-3123

Battery & EV Technology
25 Van Zant St. Suite 13
Norwalk, CT 06855
(203) 853-4266

Robert Bentley
1033 Massachusetts Ave.
Cambridge, MA 02138
(617) 547-4170

Chilton Publications
825 7th Ave.
New York, NY 10019
(212) 887-8400

EPRI Journal
PO Box 10412
Palo Alto, CA 94303
(415) 855-2000

EV World
Box 461132
Papillion, NE 68046
(402) 339-9877

Home Power
PO Box 520
Ashland, OR 97520
(800) 707-6585

Human Power Vehicle Association
PO Box 51255
Indianapolis, IN 46251
(317) 876-9478

Hydrogen & Fuel Cell Letter
Grinnell St.
PO Box 14
Rhinecliff, NY 12574
(914) 876-5988

ITS World
859 Willamette St.
Eugene OR 97401
(541) 343-1200

National Renewable Energy Lab
1617 Cole Blvd.
Golden, CO 80401
(303) 231-7681

Power Engineering
1421 S Sheridan Rd.
Tulsa, OK 74112
(918) 835-3161

Powerball Industries
2095 W 2200 St.
West Valley City, UT 84119
(801) 974-9120

Railbike Newsletter
3502 Buckskin Rd.
Coeur d'Alene, ID 83814
(208) 765-2831

Rocky Mountain Institute
1739 Snowmass Creek Rd.
Snowmass, CO 81654
(970) 927-3851

SAE
400 Commonwealth Dr.
Warrendale, PA 15096
(412) 776-4841

Whole Earth Review
PO Box 38
Sausalito, CA 94966
(415) 332-1716

The "make it or break it" issue of a hydrogen economy involves finding ways to safely store hydrogen in a dense form. A graphite nanotube storage scheme pioneered by Nelly Rodriguez offers eight times the density of gasoline, but this technology seems slow in coming out of the lab, mostly due to lifetime and reuse considerations. More on hydrogen advantages and disadvantages can be found in MUSE112.PDF on my www.tinaja.com Web site. Hydrogen safety is discussed at www-osma.lerc.nasa.gov/Ism.

Powerballs: These are simply spheres full of sodium—cracking the sphere underwater generates hydrogen. The densities involved are about the same as liquid hydrogen. All hydrocarbon pollution is eliminated by not using carbon, but to me, it seems that a lot of safety, hazmat, and recycling issues have not yet been realistically addressed. So far, this option seems to be a one-man show at Powerball Industries in Utah. More powerball details are found at www.powerball.net/index.html.

A variation on powerballs sparks aluminum under water to generate hydro-

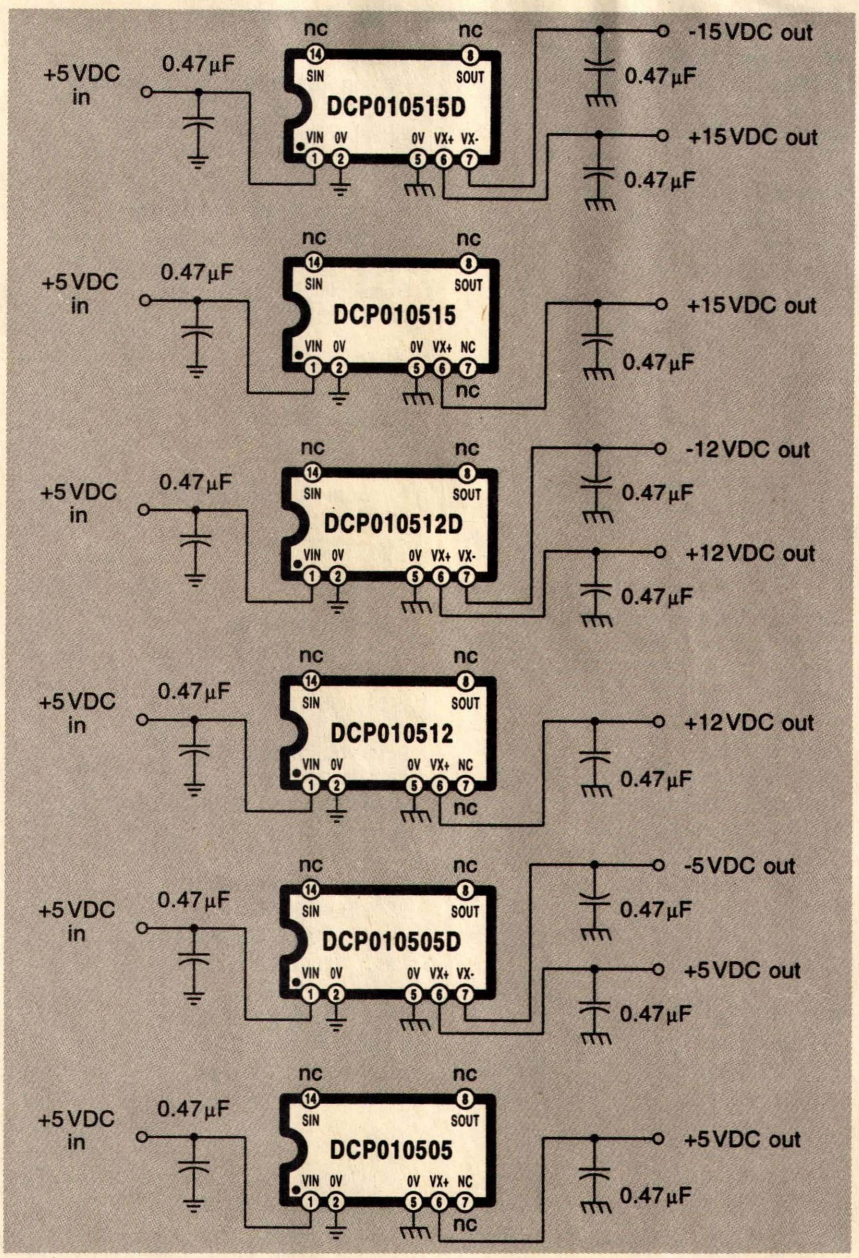


FIG. 2—A NEW LINE OF ISOLATED POWER SUPPLY hybrid devices from Burr-Brown offers 50 mils output, 1000-volt isolation and a $6 cost in a 14-pin minidip. As shown here, a variety of single and dual output devices is available.

gen, similar to an EDM spark machine. This technology appears to be mostly urban lore pseudoscience and obviously fails to deliver. If you have your electricity already onboard, you are clearly much better off routing it directly to your wheel motors. The sapphire-hard aluminum oxide waste product is highly abrasive and quite fouling as well.

Flywheels: Ordinary flywheels offer about the same energy density as lead acid batteries, while premium ones pretty much approach lithium. Safety and gyroscopic problems have been solved. A crucial limitation is windup time. If you are trying to "charge" your flywheel ten times faster than you use it, then you need ten times the drive motor. My feelings on this one is "maybe for buses".

Nitrogen power: This scheme is just plain cute. Take a tank full of liquid nitrogen and expand the gas into an ordinary heat-sunk cylinder, using ambient as the hot side of your ultra-simple heat engine. As with steam power, there's no need for a clutch or transmission. Stock air motors work just fine. You get decent efficiencies and lead-acid performance at one twentieth the cost. Summer air conditioning is also trivial.

Nitrogen power seems a student-project favorite. Several nitrogen car links appear on my Web site.

Thermoelectric recovery: Some older Peltier and related thermoelectric devices have been proposed to try and recover energy from exhaust or muffler heat. The devices to date are so inefficient that they never can even hope to return their cost, let alone accomplish anything useful. Usually a minor tire-pressure adjustment can deliver more energy savings for you.

A somewhat random assortment of my favorite alternative automotive resources is shown as this month's resource sidebar. Additional information on some of these topics is also found at www.tinaja.com/h2gas01.html

I have added access to most of the more accessible books on electric-vehicle subjects to my Web site at www.tinja.com/amlink01.html. A summary listing appears in Fig. 1. Again, I feel that hybrids blow away electrics on all counts, and will continue to do so until fundamental battery energy-density problems are economically resolved.

An Isolated Power Supply

The Burr-Brown folks have just introduced a new series of isolated hybrid power supplies. All these $6 devices are the size and shape of a 14-pin minidip, give output currents to fifty mils, and can provide safety isolation to 1000 volts.

Inside the hybrid is a 400-kHz oscillator, a tiny toroidal transformer, and some output diodes. Only two external capacitors are needed to get these to work. Obvious uses include AC-line isolation, eliminating hum and ground loops, doing high-side current sensing, and communication-line isolation.

These also let you do such tricks as very-low-frequency on-off data translation or letting both sides of a bridge rectifier tie to ground. The devices track the input voltage and offer only ten percent regulation, so some low-dropout post regulator might also be needed.

As shown in Fig. 2, various models of the device offer single and dual outputs. You can also conjure up your own custom isolated power converters through use of the individual bits and pieces separately sold as Burr-Brown's PWS745 and PWS750 products.

Another Approach

There is an obviously need for a device that to date is not available: A 79-

cent chip that starts off with a raw 110-volt AC input and then cheaply outputs isolated and hassle-free +5 volts at an amp or whatever.

There is one new device that comes close: the Harris HV2405E. That device does accept AC-line voltage as its input, but does not include the essential safety isolation. The high power (2 watts) dissipated in the input resistor also severely limits the efficiency and package size.

Even so, the device works equally well at 110 and 220 volts without any jumpers or switching. If you'd like to experiment with it, a circuit that provides a fixed 5-volt output is shown in Fig. 3, while an adjustable 5- to 20-volt version is shown in Fig. 4.

Again, be aware that the lack of isolation means that **a severe shock hazard could potentially exist**, so be extra sure to take the usual safety precautions. If you are at all unsure of what that means, or are inexperienced in working with AC circuits, maybe it would be better if you just left this one alone.

NAMES AND NUMBERS

Alfa Aesar
30 Bond Street
Ward Hill, MA 01835
(800) 343-0660

Appliance Manufacturer
29100 Aurora Rd #200
Solon, OH 44139
(216) 349-3060

Burr-Brown
6730 S Tucson Blvd.
Tucson, AZ 85706
(520) 746-1111

CastCraft
PO Box 17000
Memphis, TN 38187
(901) 682-0961

Harris Semiconductor
2401 Palm Bay Rd. NE
Palm Bay, FL 32905
(800) 442-7747

Home Power
PO Box 520
Ashland, OR 97520
(800) 707-6585

Integrated Design & Manufacturing
One SME Drive
Dearborn, MI 48128
(313) 271-1500

Kentek
19 Depot Street
Pittsfield, NH 03263
(800) 432-2323

Math Works/Matlab
24 Prime Park Way
Natick, MA 01760
(508) 647-7000

MCP Systems
511 Commerce Drive
Fairfield, CT 06432
(800) MCP-0222

Polytek Development
55 Hilton St.
Easton, PA 18042
(610) 559-8620

Science/AAAS
1333 H St. NW
Washington, DC 20005
(202) 326-6400

Synergetics
Box 809
Thatcher, AZ 85552
(520) 428-4073

Texas Instruments
PO Box 809066
Dallas, TX 75380
(800) 336-5236

THAT Corp.
734 Forest St.
Marlborough, MA 01752
(508) 229-2500

Time Compression Technology
203 N LaSalle #2100
Chicago, IL 60601
(312) 558-1548

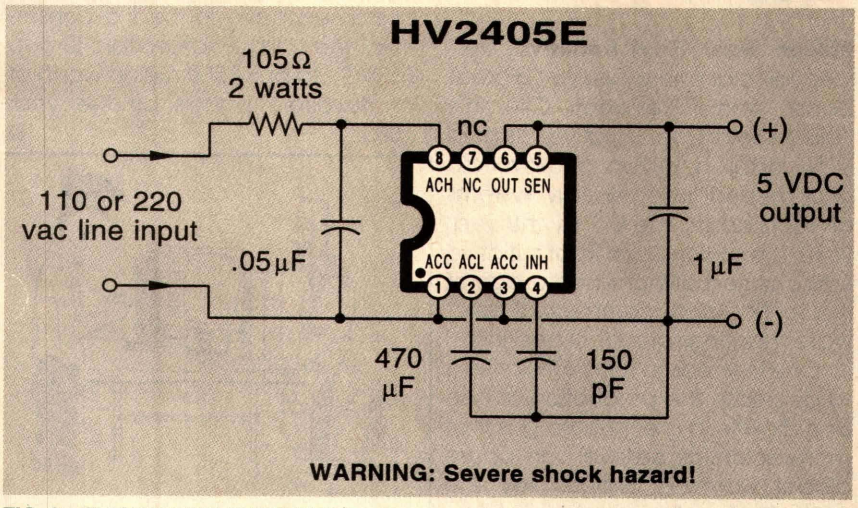


FIG. 3—THIS AC-LINE OPERATED 5-volt power supply uses a new Harris chip. Note that safety isolation is NOT provided so the potential for a severe shock hazard exists.

New Tech Lit

From Texas Instruments, comes a new two-volume amplifier-chip databook library. From Harris, there's a nice booklet about *Semiconductor Solutions for Multimedia, Video, and Imaging*.

From That Corporation, comes a new $3 rms level-detector IC that provides wide bandwidth, a log output, and crest factors as high as eight. It is intended for electronic music apps.

New from NTE is a fat semiconductor directory that cross-references over 260,000 chips of one sort or another. From Aesar comes a free periodic table of the elements wall poster.

Certain new low temperature alloys that melt at 158 degrees Fahrenheit are offered by MCP Systems. Their intended use is for low-cost prototyping and mold-making intermediates. Useful casting plastics and mold-making materials are sold by Polytek, who has a free *Developments* newsletter. Another source is CastCraft.

A wide variety of educational and other laser products are stocked by Kentek. Ask for catalog #118.

A new magneto-coloric magnetic refrigeration material is described in *Science* for March 27, 1998 on page 2045. That material is six times more effective than the previous ones and operates at room temperature. Thus, only one sixth of the newer material is needed for a home refrigerator or similar heat-transfer system.

For those unfamiliar with how this works, basically any magnetic material absorbs heat energy whenever it is magnetized and releases heat energy when raised above its Curie Point, the temperature where it totally loses its magnetic properties. While not quite solid-state (your material has to slowly move from

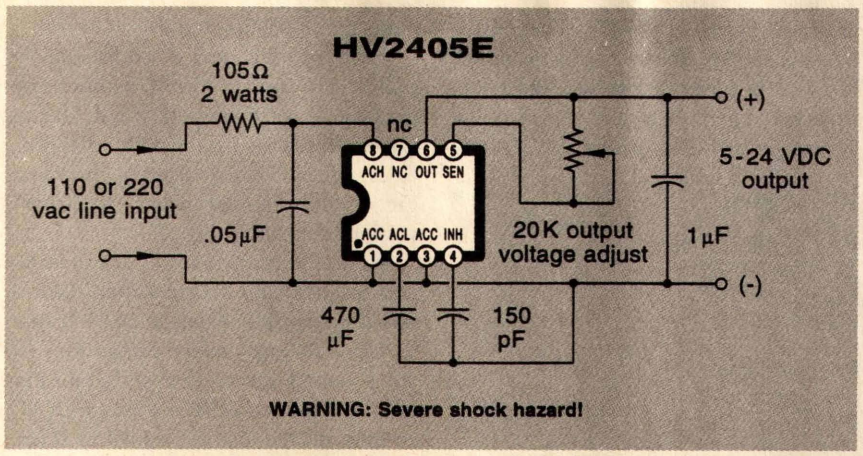


FIG. 4—ADDING A POTENTIOMETER to the basic circuit in Fig. 3 yields an adjustable supply with a 5- to 24-volt output range.

source to sink and back again), the mechanics involved are simpler than a compressor, and no freon or other fluids are involved. Additional magnetic-refrigeration coverage appears in the March 1998 issue of *Appliance Manufacturer* on page 14. More details on magnetic refrigeration can also be found in HACK33.PDF and RESBN63.PDF on my Web site, and in volume III of my "Hardware Hacker" reprints.

Walt Pyle has released his new *Hydrogen Solar Chronicles* book, a useful hands-on compendium of his collected reprints from *Home Power* magazine. More information on his book is at www.tinaja.com/h2gas01.html.

Time Compression Technologies is a new trade journal on Santa Claus machines, rapid prototyping systems, CAD/CAM, and industrial design. A lot more on the Santa Claus machines themselves and lots of links are at www.tinaja.com/santa01.html.

Our second trade journal for this month is the new *Integrated Design & Manufacturing*.

Some nice reprints on wavelets are newly offered by the folks at MatLab. Additional resources and links are at www.tinaja.com/wave01.html.

Some great bargains in Tektronix 2213 oscilloscopes newly appear at www.tinaja.com/barg01.html.

Bunches of freebie tutorials about wireless and communications topics appear at www.iec.org.

For all the fundamentals of active filters in an easy-to-understand and easier-to-use format, check out my *Active Filter Cookbook*. Ordering details are found in my nearby Synergetics ad, or pick up your catalog instantly online at my www.tinaja.com/synlib01.html.

Magic Sinewaves are a brand new opportunity that lets you generate surprisingly efficient and elegantly simple high-power waveforms for use in industrial, automotive, solar, and home-energy efficiency areas. I've recently posted a lot of new files to www.tinaja.com/magsn01.html.

Our usual reminders that most of the mentioned resources appear in the Names and Numbers or Alternative Automotive Resources sidebars, that we offer a free US helpline per the nearby box, and that my Guru's Lair Web site is www.tinaja.com. EN

SOLAR POWER

(continued from page 54)

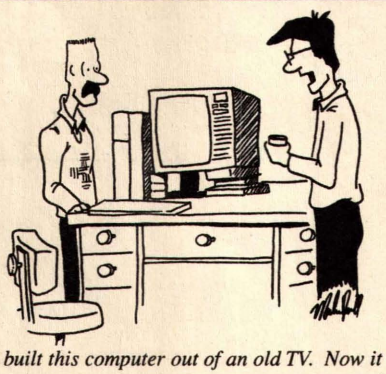
is rated at one kilowatt. Like Uni-Solar PV Shingles, only a small portion of the roof needs to be covered with the photovoltaic tiles to provide sufficient electricity.

Million Solar Roof Initiative. Residential solar energy will get a great boost from President Clinton's "Million Solar Roof Initiative." Its goal is to install a million photovoltaic and thermal solar energy systems on roofs across the U.S. by the year 2010. The Million Solar Roof Initiative is also aimed at increased usage of residential and commercial solar water heating solar pool heating.

One key reason for the initiative is to decrease the production of carbon dioxide, a greenhouse gas that many scientists believe can cause global warming. Experts say the amount of carbon dioxide not produced by a million solar roofs would be like getting 850,000 cars off the road. These million solar roofs could also reduce energy consumption, pollution, and the country's reliance on foreign petroleum. Further, by the year 2010, about 70,000 new high-technology jobs could be created to meet the new demand for photovoltaic, solar water heating, and related technologies. The initiative will bring solar power not only to private homes, but also to schools, libraries, and large and small businesses. Finally, as economies of scale kick in as a result of increased usage and mass production, the initiative is seen as a way to reduce the cost of solar-energy products.

The Million Solar Roof Initiative is being led by the U.S. Department of Energy and involves the building industry, local governments, state agencies, the solar industry, electric utilities, and non-governmental organizations. The federal government is taking the lead by accelerating its use of solar energy. It is important to note that the government alone owns nearly a half-million buildings and spends $3 billion annually for electricity, making it the world's largest single user of energy. Add to that the more than 76-million residential buildings and almost five-million commercial buildings, plus an additional 38 million projected by the year 2010 in the U.S. alone, and it is easy to see that the potential for solar roofs is tremendous.

Because of this potential, electric utilities are already getting in on the action. For example, some 68 utilities serving 40% of U.S. electrical customers have formed a consortium, the Utility Photovoltaic Group (UPVG), to buy $500 million worth of photovoltaic panels by the year 2003. Ω



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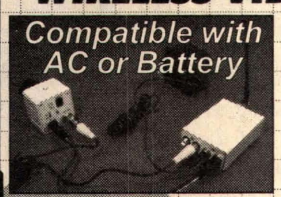

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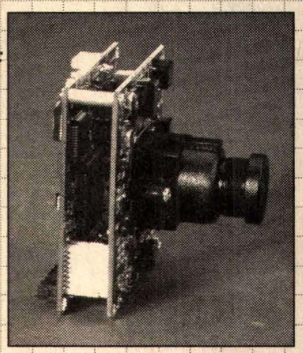

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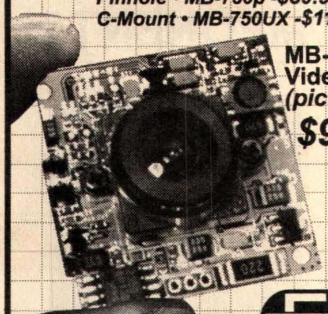

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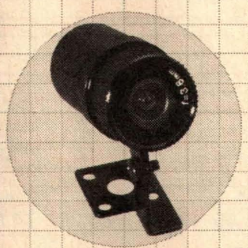

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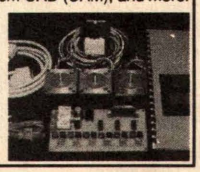

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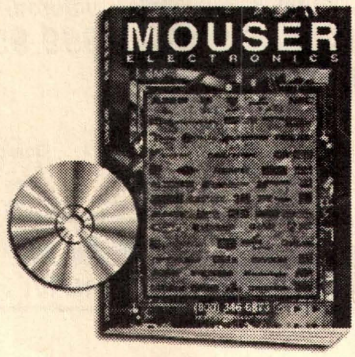

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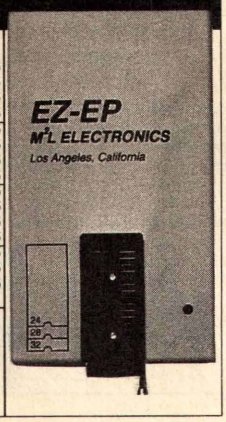

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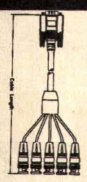

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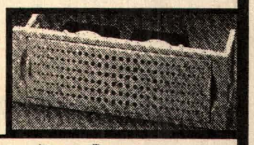

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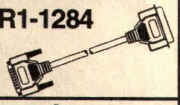

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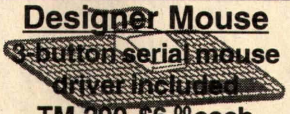

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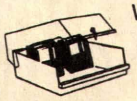

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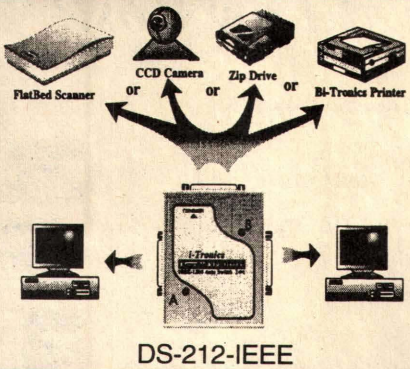

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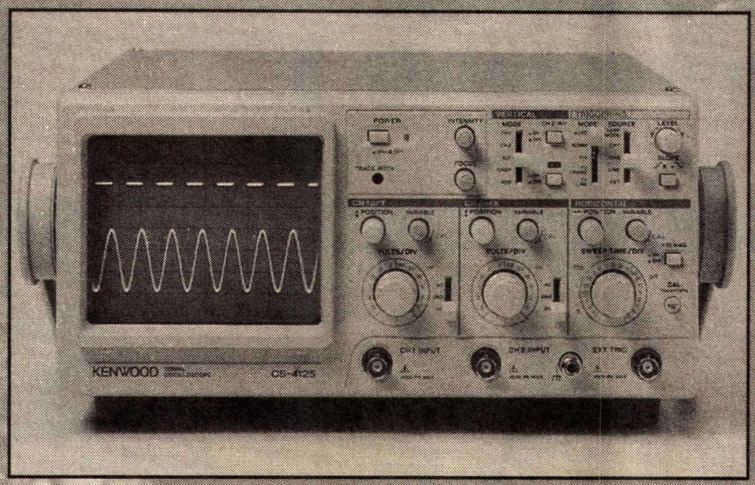

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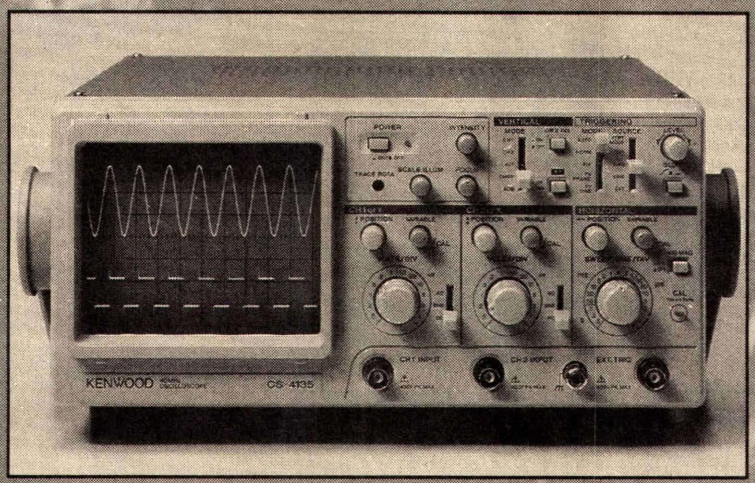

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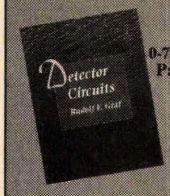

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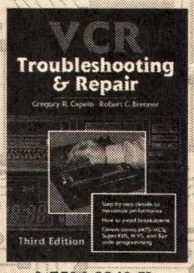

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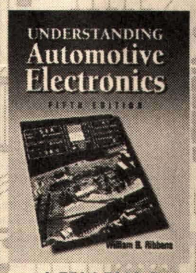

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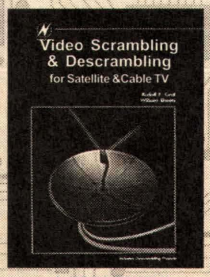

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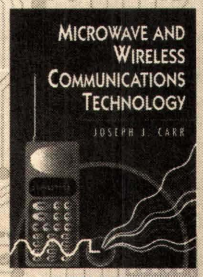

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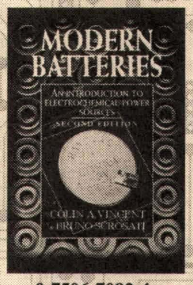

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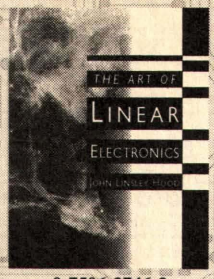

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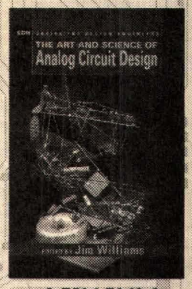

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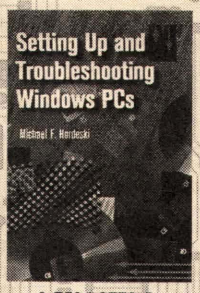

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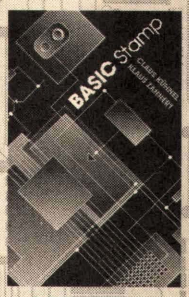

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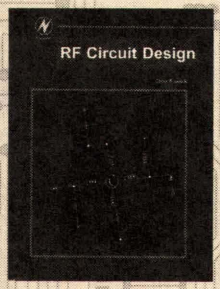

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Liquid Crystal Displays

240x64 dot LCD with built-in controller.

AND 4021ST-EO. *Unit is EL back-lit.* **$59.00 or 2 for $109.00** *or*
OPTREX. DMF5005 *(non back-lit)* **$49.00 or 2 for $89.00**
20 character x 8 line
7¼L x 2½H
The built-in controller allows you to do text and graphics.

Alphanumeric—parallel interface

16x1.....$7.00	20x2.....$10.00	32x2.....$8.00
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16x2 (lg. char.)....$10.00	24x2.....$10.00	40x4.....$20.00
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5V power required • Built-in C-MOS LCD driver & controller • Easy "microprocessor" interface • 98 ASCII character generator • ***Certain models are backlit, call for more info.***

Graphics and alphanumeric—serial interface

size	Mfr.	price	size	Mfr.	price
640x480 (backlit)	Epson	$25.00	480x128	Hitachi	$10.00
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480x128 (backlit)	ALPS	$10.00	240x64	Epson	$15.00
			160x128	Optrex	$15.00

6" VGA LCD 640X480, Sanyo LMDK55-22 **$25.00**

Laser Products

HeNe Laser Head (10Mw max. output) TEMOO, 15.5" long MFG: NEC **$89.00**
Laser Power Supply (for HeNe tube) **$79.00**

Laser Scanner Assembly $19.00
Assembly intended for a laser printer. Includes laser diode, polygon motor (6 sided) and misc. optics and lenses.

LASER DIODE (5mW) with collimator **$20.00**

VISIBLE LASER DIODE: 5mw at 670nm **$15.00**
Index guided. Threshold current 40 ma typical.

3 and 4mW, 1,300nm LASER DIODES, 5.6mm package, $15.00
Mitsubishi Electric part number ML701BIR-E21A, General specs are:
1. Vop=1.25, Beam Divergence 25.6° x 28.6°; 2. Tc=24°C, Iop=19 to 20mA, ITH=10.7mA; 3. Wavelength range between 1,280nm and 1,330 nm

POLYGON MOTOR UNIT & DRIVER $69.00

Ten-sided first surface mirror mounted on an armature that spins at 125 revolutions per second yielding a beam sweep rate of 1250 sweeps per second. The driver for the polygon unit requires 24 volts and plus and minus 12 volts to operate. There is also an f-theta lens in front of the polygon scanning mechanism with a three inch diameter. Great for optical experiments, etc. Very high quality units. (MFR: JAPAN ELECTRONICS)

POS & Bar Code

MAGNETIC CARD READER $25.00

Includes: • 20 character dot matrix display with full alpha-numeric capability • keypanel with full alpha-numeric entry • separate 7.5 VDC/0.5 Amp power supply • standard telephone interface extension cord • lithium battery and flat-cone speaker.

HP bar code wand (HBCS 2300).....$25.00

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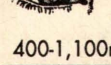
SWITCHING POWER SUPPLYS $12.00 or 2 for $20.00 115/230 Volts
73 WATT (2) 4 pin power connectors attached • Dim: 8.5" L x 4.5" W x 2" H
Output: +5V @ 2-9.75, A, +12V @ 0-1.5 A, -5V @ 0-0.4 A, -12V @ 0-0.5 A
60 WATT Dim: 8¾ x 4¼ x 3 • Output:5V @ 6A + 12V @ 1A - 5V @ 1A - 12V @ 1A

Charge Coupled Devices



"The Spy In The Sky" $29.00 — **Matrix Type**

Thomson 576X550 pixel CCD
400-1,100nm resolution and responsivity. **$500.00 Original cost device**

Sony CCD Imager - designed for black and white composite video cameras. Picture elements: 384 (H) x 491 (V) $29.00
Chip size 10.7 (H) x 9.3 (V) mm² • Unit cell size 23.0 (H) x 13.4 (V) um².
Ceramic 24 pin DIP package • Mfr: Sony, Part# 016AL

4096 element CCD $15.00
1024 element CCD $10.00 — **Linear Type**
2048 element CCD $10.00 • 1728 element CCD $10.00

Miscellaneous

ADAPTEC 4070A (RLL) OR 4000A (MFM), SCSI Controller, your choice $25.00

IBM 370 option XT and AT emulation boards $25.00

Monitors

Non-Enclosed TTL

Comes with pinout. 12V at 1.4 Amp input • Horizontal frequency 15Khz. • Ability to do 40 and 80 column.
5 inch Amber $25.00 • 7 inch Amber $25.00
9 inch Amber or Green $25.00

5" COLOR MONITOR $39.00

• Flat Faceplate • 320 x 200 Dot Resolution • CGA & Hercules Compatible
• 12 VDC Operation • 15.75 KHz Horiz. Freq. • 60 Hz Vert. Sync. Freq.
• Open Frame Construction • Standard Interface Connector • Degaussing Coil included • *Mfr. Samtron*

9" COLOR SVGA MONITOR $249.00

Fully Enclosed – Tilt and swivel type.

Hacker Corner

EMBEDDED 486 COMPUTER $99.00

Complete enhanced Intel 486SX-33 based computer in ultra small (9-7/8L x 6-5/8W x 3-1/8H) case. Ideal for embedded operations or as a second computer. Features include: • One 16 bit ISA slot • 3 serial ports plus dedicated printer port • Parallel optical coupled adapter port • Built in IBM PC/AT keyboard port • On board VGA video and port • Uses standard SIMM up to 32 MB • BIOS is PC/AT compatible

Unit has a backup Ni-Cd battery system in case of power failure (5 min. backup time) and lockable front cover to prevent floppy drive access. Mounting / interface provisions for standard 3.5" laptop floppy and 2.5 inch hard drives. Comes with very comprehensive manual.

Encased Spread Spectrum RF Modem $199.00

The ProxLink Radio Module is a small communication device which replaces cables between RS-232 devices with wireless RF (Radio Frequency) technology. Attaching a pair of ProxLinks to any two devices with three wire asynchronous RS-232 ports allows wireless data transmittal at rates up to 19.2 Kbaud (full duplex) over a range of 500 - 800 feet. Modules use 900 MZ spread spectrum radio for communication which does not require an FCC site license. A variety of configuration information (radio channel, baud rate, serial port configuration, etc.) can be programmed into module's non-volatile memory by host PC to provide compatibility and avoid overlapping systems. Configuration changes are supported by menu driven, on-board software. Commonly used Terminal Emulation software and transfer protocols can be used for configuring modules and transferring data between computers. ProxLinks require only 6-9 VDC (350 mA), RS-232 (9 pin sub - D) interface, and small (~ 4") whip antenna for operation. Unit size is 4.0" x 6.5" x 0.75". Installation schematics and application details available.

US made Micronics 486 VLB ALL in ONE $39.00 or 2 for $69.00
motherboard, supports 3.4 or 5V CPU, at either 25 or 33 mhz basic clock. Can use AMD or Intel from 486SX25 thru 486DX4-100 to HOT new AMD 5X86-133 cpu. On board SVGA video. On board 1 meg video ram expandable to 2 meg with ATI Mach 2 chip set. On board 2 high speed serial ports, 1 printer port, floppy and IDE hard drive controller. On board 256K cache. Uses 72 pin simm memory. Landmark speed rating of 479 with AMD chip.

Board will not fit standard All in One case because of non standard location of riser board. VLB riser board is included with motherboard.

COLOR CCD CAMERA $149.00

• 12 VDC • 1/3-inch, CCD area image sensor • 514 (horizontal) x 491 (vertical) • 2:1 interlaced • 15.734 kHz (horizontal), 59.94 Hz (vertical) • 330 horizontal and 350 vertical lines • 10 Ix • 1V, NTSC signal format • Lens: 1/3-inch, fixed focus (F:2.8 f:5.6) • Dimensions: (W) 67 (2.63) x (H) 34 (1.45) x (D) 112.6 (4.43)

SONY Miniature Color LCD Display (LCX005BKB) $29.00

• 1.4 CM (0.55 inch) Diagonal Full Color Display • Built In Horizontal and Vertical Drivers • Delta Dot Pattern for High Picture Quality - 537 dots (H) x 222 dots (V) • Compatible with NTSC & PAL Format and Sync Inputs • 12 VDC Operation with -1 to +17 V RGB Signal and Driver Input Voltage • Excellent Display for Virtual Reality Projects, Viewfinders, and Miniature Test Equipment Displays • Pin Outs and Specification Included • Unit Requires Clock, Synchronization and Video

CELL SITE TRANSCEIVER $49.00 2 for $89.00

These transceivers were designed for operation in an AMPS (Advanced Mobile Phone Service) cell site. The 20 MHz bandwidth of the transceiver allows it to operate on all 666 channels allocated. The transmit channels are 870.030-889.980 MHz with the receive channels 45 HMz below those frequencies. A digital synthesizer is utilized to generate the selected frequency. Each unit contains two independent receivers to demodulate voice and data with a Receive Signal Strength Indicator (RSSI) circuit to select the one with the best signal strength. The transmitter provides a 1.5 watt modulated signal to drive an external power amplifier. channel selection is accomplished with a 10 bit binary input via a connector on the back panel. Other interface requirements for operation are 26 VDC (unregulated) and an 18.990 MHz reference frequency for the digital synthesizer. The units contain independent boards for receivers, exciter, synthesizer, tunable front end, and interface assembly (which includes power supplies and voltage-controlled oscillator). Service manual, schematics and circuit descriptions included.

Encased Black & White Composite CCD Camera with Adapter
IR viewing to 1000 nm 7 ½ L x 2 ¾ W x 1 ¾ H
Comes complete with CCD camera, mounting nut on bottom of casing, 12VDC power supply. Excellent low light capability, standard RCA NTSC video out. **$89.00**
Great for: entryway security/remote monitoring, video conferencing/desktop video conferencing **2 for $159.00**
This miniature camera is perfect for multimedia computer applications as well as security and surveillance. NTSC output allows use with all popular video digitizing boards for Apple Macintosh and Microsoft video for Windows. Connects directly to any composite monitor or VCR with "video" input. Its razor-sharp wide-angle lens focuses from two inches to infinity and its state-of-the-art CCD technology accurately captures 16 level grayscale images for Quick Time movies and still pictures. Records at 30 frames per second and 260 lines resolution with excellent low light capability. Uses 12VDC (adapter supplied) and standard RCA cable.

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Microphone Mixer Mono Amp.	▲	20.79
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Digital Clock with Melody Alarm	▲	25.00
Stereo Pre-Amp with Mic Amp.	▲	10.78
Mini Stereo Multi-Input Amp.	▲	30.50
130-in-one Electronic Lab	▲	29.99

SEE OUR CATALOG FOR MORE KITS !

Clearance Sale — FM Wireless Microphone TY-35

This is a low power real FM transmitter. Transmit frequency within 88-108 MHz. Transmit range about 200 ft. It has high sensitivity sound pickup by a capacitance microphone. May be used strictly for series purposes such as remote wireless monitering.

Kit ~~$ 12.50~~ **6.99**

4½ Digital LED Panel Meter SM-48

Clearance Sale

This precision digital meter is a stand-alone voltmeter-ammeter or can interface with a computer! 4½ digit 0.55" LED display. Temperature compensated to 100 PPM/°C. Operating temperature range is 0°C to +70°C. Outputs include BCD date, Busy and strobe. Panel reading can be latched on hold.

Kit ~~$ 39.00~~ **20.00**

Stereo Loudspeaker Protector TY-25 ▲

Super fast acting relay protects speakers against destructive DC voltages. Can connect directly to a power amplifier or can use a separate power supply. Has a 3 second turn-on delay to avoid turn-on thumps.

Kit: $ 16.75

Regulated DC Power Supply TR-503 ▲▲

It is short circuit proof & has overload protection. Output voltage is variable over a range of 0-50 volts. Current limit trip is adjustable up to max of 3A. May use Mark V #002 transformer.

Kit: $ 18.75

Fluorescent Light Driver TY-2 ▲ (1 lb.)

This unit drives 6-40 watts fluorescent light for portable and emergency use. Works from a 7.2 - 16 VDC battery. Includes a "Hi-Efficiency Switching Mode IC Driving Circuit" suitable for use with different lights.

Kit:$ ~~14.75~~ **9.99**

120-250W Mosfet Power Mono Amplifier AF-2 (6 lbs.) ▲▲

Power Output: 250W into 4 ohms RMS(42VX2 6A transformer is used). 120W into 4 ohms RMS(33VX2 4A transformer is used). Frequency Response: 3Hz-22,000Hz. THD: <0.03%. Signal to Noise Ratio: 91dB. Sensitivity: 1V RMS at 47k. Load Impedance: 4 or 8 ohms. Power Requirement: ±46VDC 4A or ±60VDC 6A. May use Mark V model 012 Transformer. Suggested Capacitor 8,200uf 100V Model 020. Suggested Metal Cabinet LG-1925.

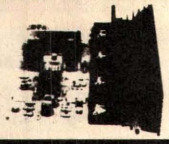
Kit: $ ~~89.80~~ **76.33** Asmb.$ 114.80

500-in-one Electronic Lab Kit

KA-904 $129.99

Contains its own computer with a simple explanation of the basic(Assembler) language required for operation. Compile programs to discover how computers operate while gaining an understanding of hardware & software. With easy-to-follow manual which explains by comprehensive diagrams. Requires 4 "AA" batteries.

300W High Power Mono Amplifier TA-3600 (5 lbs.) ▲▲▲



Power Output: 300W into 8 ohms RMS. 540W music power into 8 ohms. Frequency Response: 10Hz-20KHz. THD: < 0.05%. Sensitivity: 1V RMS at 47K. Power Requirement: 60 to 75 VDC at 8A. May use Mark V Model 007 or 009 Transformer. Suggested Capacitor: 8,200uf 100V Model 020 Capacitor. Suggested Metal Cabinet LG-1925.

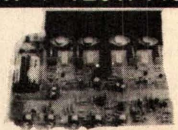
75.65
Kit:$ ~~89.00~~
Asmb.$ 115.00

150MHz 8 Digit Frequency Counter SM-100 (2 lbs.)

It is used for adjustment, test & repair of any kind of high frequency circuit products. It can give up to 8 digit of resolution for a wide frequency range 10Hz - 150 MHz. The last input frequency can HOLD on the display for future reference & comparison. The circuit structure is compact & reliable for the most updated A/D LSI circuitry. The input impedance is 1M ohm. ▲▲▲

Kit:$ ~~79.00~~ **68.00**
Asmb.$ 99.00

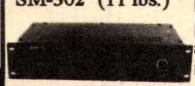
120W + 120W Pre & Main Stereo Amplifier TA-800MK2 (4 lbs.) ▲▲



Power Output: 120W into 4 ohms RMS. 72W into 8 ohms RMS. Frequency Response: 10 - 20 KHZ. THD: < 0.01%. Tone Control: Bass ±12dB, Mid ±8dB, Treble ±8dB. Sensitivity: Phono Input, 3mV into 47K. Line, 0.3V into 47K. Signal to Noise Ratio: 86dB. Power Requirement: 40V DC @ 6A. May use Mark V Model 001 or 008 Transformer. Suggested Metal Cabinet Model LG-1924.

Kit: $ ~~67.92~~ **61.13** Asmb.$ 86.95

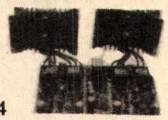
60 + 60W Stereo Power Amp. SM-302 (11 lbs.) ▲▲



It provides 3 input jack pairs. One pair accept a high impedance micro-phone. The two remaining pairs are for high & low level input sources. Power Output: 60W per channel into 4 ohms RMS. 20Hz-20KHz. THD:<0.1%. Input Sensitivity :Mic /Guitar 10mV, Hi 380mV, Lo 640mV.Ready to plug in when assembled.

Kit:$ ~~85.00~~ **76.50**

80W + 80W Pure DC Stereo Main Power Amplifier TA-802 (4 lbs.) ▲▲



Power Output: 80W per channel into 8 ohms. THD: < 0.05%. Frequency Response: DC to 200 KHZ, -0 dB, -3dB @ 1W. Power Requirement: 30V AC X 2 @ 6A. May use Mark V Model 001 or 008 Transformer. Suggested Capacitor 8,200uf 50V Model 017. Suggested Metal Cabinet LG-1924

42.45
Kit: $ ~~49.94~~
Asmb.$ 69.94

30W + 30W Pre & Main Stereo Amplifier TA-323A (1 lb.) ▲

Power Output: 30W into 8 ohms RMS per channel. THD: < 0.1% from 100 HZ to 10 KHZ. Sensitivity: Phono 3mV @ 47K. Tuner, Tape 130mV @47K. Signal to Noise ratio: 80dB. Power Requirement: 22 to 36V AC, 3A. May use Mark V Model 002 Transformer. Suggested Cabinet LG-1684.

29.25
Kit: $ ~~32.50~~ Asmb.$ 50.50

300-in-one Electronic Lab Kit ▲▲

Learn about transistors, capacitors & electronic circuits. Build electronic games, battery checker & more. It even includes a breadboard for adding your own components. Complete with easy-to-follow manuel. Requires 6 "AA" batteries. (6 lbs.)

$ ~~59.99~~ **49.99**

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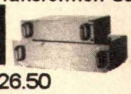
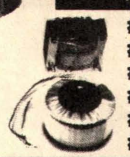


LG-1273	3x12x7" (4 lbs.)	$ 26.50
LG-1684	4x16x8" (7 lbs.)	32.50
LG-1924	4x19x11½" (10 lbs.)	38.25
LG-1925	5x19x11½" (10 lbs.)	42.00
LG-1983	2¼x19x8" (7 lbs.)	35.25
LG-1927	7x19x11½" (15 lbs.)	52.50

Transformers (5-12 lbs.)
**Toroidal Transformers



# 001	28V/30V x2	6A	$ 30.00
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# 003	40V x2	6A	32.00
# 008**	28V/30V x2	6A	42.00
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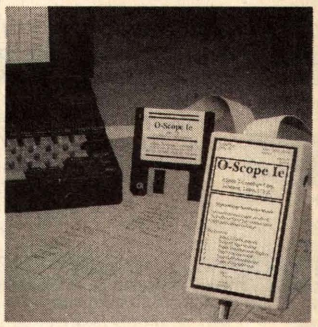

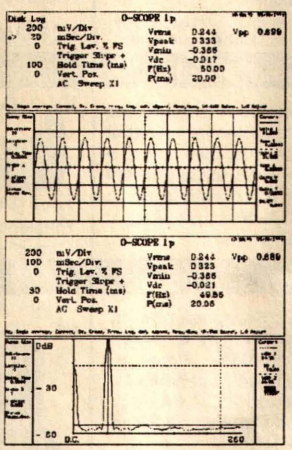

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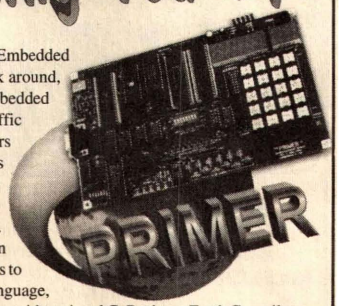

Are you interested in Microprocessors & Embedded Control Systems? If not you should be! Look around, just about everything these days has an embedded microprocessor in it. TVs, cars, radios, traffic lights & even toys have embedded computers controlling their actions. The Primer Trainer is the tool that can not only teach you how these devices operate but give you the opportunity to program these types of systems yourself. Examples & exercises in the Self Instruction manual take you from writing simple programs to controlling motors. Start out in Machine language, then move on to Assembler, & then continue on with optional C, Basic, or Forth Compilers. So don't be left behind; this is information you need to know!

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- Using a Photocell to Detect Light Levels
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- Constructing a Capacitance Meter
- Motor Speed Control Using Back EMF
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- Bus Interfacing an 8255 PPI
- Using the Primer as an EPROM Programmer
- DTMF Autodialer & Remote Controller (New!)

The PRIMER is only $119.95 in kit form. The PRIMER Assembled & Tested is $169.95. This trainer can be used stand alone via the keypad and display or connected to a PC with the optional upgrade ($49.95). The Upgrade includes: an RS232 serial port & cable, 32K of battery backed RAM, & Assembler/Terminal software. Please add $5.00 for shipping within the U.S. Picture shown with upgrade option and optional heavy-duty keypad ($29.95) installed. Satisfaction guaranteed.

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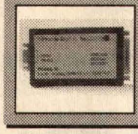
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- 2 ANALOG OUTPUTS
- 2 COUNTERS-24 BIT

MODEL 100 ..... $279

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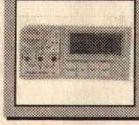
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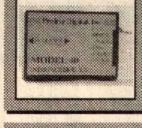
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CIRCLE 215 ON FREE INFORMATION CARD

NEW LITERATURE

continued from page 34

tems, as well as well as optical tools and vacuums. Accessories and items for computers, networks, and telecommunications are also included. Hewlett-Packard products are covered in a separate section.

Each item is accompanied by a full-color photo. A complete index is found at the back of the catalog.

Net Guide: Your Complete Guide to the Internet and Online Services

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Dell Publishing
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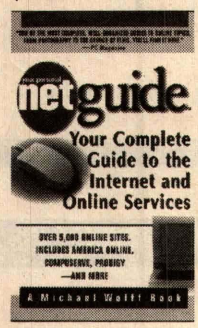
$7.99



CIRCLE 341 ON FREE INFORMATION CARD

In March 1996, a Nielsen survey found that 56 million people in the U.S. and Canada have access to the Internet. At this growth rate, over 50% of the U.S. population will be Internet users by the year 2000. With as many as 50,000 new Web sites beginning each day, Net-users will welcome this moderately priced, easy-to-use resource guide to Internet services and sites.

It is a comprehensive volume divided into helpful sections that provide simple, practical advice about surfing the Net: from choosing a modem to finding the right online service to locating obscure sites. Subject areas include Entertainment (movies, TV, music), Sci-Fi, Fun & Games (comics, cartoons, video games), Home & Health, The Digital World, Virtual Newsstand, Politics & Government, and Dollars & Sense (personal finance and taxes).

Over 5000 online sites are included. In addition to other subject areas, hundreds of Internet addresses for current information on topics ranging from TV shows to literature are provided.

This book is the first in Dell's series of Internet guidebooks: *NetSci-Fi*, *NetStudy*, *NetSports*, *NetMoney*, and *NetDoctor*. All of them are shorter guides to the best sites to visit in their particular interest area, and they all include commentary and site reviews.

Tools, Test Equipment and Supplies—1998 Edition

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335 Willow Street
N. Andover, MA 01845
Tel: 978-682-2000
Fax: 978-688-7829
Web: www.contacteast.com
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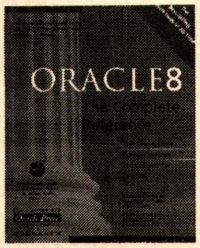
CIRCLE 342 ON FREE INFORMATION CARD

Designed for engineers, managers, technicians, and hobbyists, this catalog is filled with hundreds of new test instruments and tools. Featured are quality products from brand-name manufacturers for testing, repairing, and assembling electronic equipment. New product highlights include Fluke's redesigned 70 "Series III" DMMs; Tektronix' TDS "600 Series" digital real-time oscilloscopes; and Metcal rework stations. Complete specifications are given for each product.

There is a full selection of DMMs, portable and bench-top digital storage scopes, custom tool kits, power supplies, EPROM programmers, soldering and desoldering equipment, and breadboards. In addition, heat guns, measuring tools, adhesives, and precision hand tools are covered, as well as reference books. Also included are the popular lines of communication test equipment, ESD-protection products, ozone safe cleaners, magnifiers, inspection equipment, workbenches, tool cases, and more.

Oracle8, The Complete Reference

by George Koch and Kevin Loney
Osborne/McGraw Hill
2600 Tenth Street
Berkeley, CA 94710
Tel: 800-264-4729 or 510-549-6600
Fax: 510-549-6603
Web: www.osborne.com
$59.99



CIRCLE 343 ON FREE INFORMATION CARD

This expanded reference guide gives in-depth coverage of object technology. It is the single most comprehensive sourcebook/CD-ROM package available for Oracle Server. Giving complete, encyclopedic coverage of Oracle Server software releases 7 through 8, this volume will be invaluable for database administrators, developers, programmers, and high-end users.

Divided into six logical parts, this special hard-cover edition contains over 200 pages of new material. Quick, easy-to-follow references to critical database concepts and new features of the program provide a handy guide to readers.

This edition covers new material on implementing object technology in Oracle8, an introduction to database concepts, detailed information on how to develop applications with Oracle Context, and a complete presentation of SQL, including a new chapter on operations for beginning users. Other material includes "A Hitchhiker's Guide to the Oracle Data Dictionary," an alphabetical command reference that lists the syntax and sample usage for each command, and an easy-to-reference list of the downloadable tables used in the book.

The included companion CD-ROM for Windows 3.1 and Windows 95 offers a fully searchable electronic version of the book, which will give readers quick and convenient access to all its information. The CD contains all of the tables, code, and examples from the book, which were previously sold separately. EN

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HOW TO WRITE YOUR AD

TYPE or PRINT your classified ad copy CLEARLY (not in all capitals) using the form below. If you wish to place more than one ad, use a separate sheet for each additional one (a photo copy of this form will work as well). Place a category number in the space at the top of the order form (special categories are available). If you do not specify a category, we will place your ad under miscellaneous or whatever section we deem most appropriate.

We cannot bill for classified ads. **PAYMENT IN FULL MUST ACCOMPANY YOUR ORDER.** We do permit repeat ads or multiple ads in the same issue, but in all cases, full payment must accompany your order.

WHAT WE DO

The first word and company name of each ad are set in bold caps at no extra charge. No special positioning, centering, dots, extra space, etc. can be accommodated.

RATES

Our classified ad rate is $2.50 per word. Minimum charge is $37.50 per ad per insertion (15 words). Any words that you want set in bold are each .40 extra. Indicate bold words by underlining. Words normally written in all caps and accepted abbreviations are not charged anything additional. State abbreviations must be post office 2-letter abbreviations. A phone number is one word.

If you use a Box number you must include your permanent address and phone number for our files. ADS SUBMITTED WITHOUT THIS INFORMATION WILL NOT BE ACCEPTED.

For firms or individuals offering Commercial products or Services. **Minimum 15 Words.** 5% discount for same ad in 6 issues within one year; 10% discount for same ad in 12 issues.**Boldface (not available as all caps),** add .40 per word additional. **Entire ad in boldface,** add 20%. **Tint screen behind entire ad,** add 25%. **Tint screen plus all boldface ad,** add 45%. **Expanded type ad,** add $4.00 per word.

General Information: A copy of your ad must be in our hands by the 13th of the fourth month preceding the date of issue (i.e. Sept issue copy must be received by May 13th). When normal closing date falls on Saturday, Sunday or Holiday, issue closes on preceding work day. Send for the classified brochure.

DEADLINES

Ads not received by our closing date will run in the next issue. For example, ads received by November 13 will appear in the March issue that is on sale January 17. ELECTRONICS NOW is published monthly. No cancellations permitted after the closing date. No copy changes can be made after we have typeset your ad. NO REFUNDS, advertising credit only. No phone orders.

CONTENT

All classified advertising in ELECTRONICS NOW is limited to electronics items only. All ads are subject to the publishers' approval. WE RESERVE THE RIGHT TO REJECT OR EDIT ALL ADS.

AD RATES: $2.50 per word, Minimum $37.50

Send you ad payments to:
ELECTRONICS NOW 500 Bi-County Blvd, Farmingdale, NY 11735-3931

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100 -- Antique Electronics
130 -- Audio-Video Lasers
160 -- Business Opportunities
190 -- Cable TV
210 -- CB-Scanners
240 -- Components
270 -- Computer Equipment Wanted
300 -- Computer Hardware
330 -- Computer Software
360 -- Education
390 -- FAX
420 -- Ham Gear For Sale
450 -- Ham Gear Wanted
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540 -- Music & Accessories
570 -- Plans-Kits-Schematics
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690 -- Security
710 -- Telephone
720 -- Test Equipment
730 -- Wanted

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9 - $37.50	10 - $37.50	11 - $37.50	12 - $37.50
13 - $37.50	14 - $37.50	15 - $37.50	16 - $40.00
17 - $42.50	18 - $45.00	19 - $ 47.50	20 - $50.00
21 - $52.50	22 - $55.00	23 - $57.50	24 - $60.00
25 - $ 62.50	26 - $65.00	27 - $67.50	28 - $70.00

29 - $72.50	30 - $75.00	31 - $77.50	32 - $80.00
33 - $82.50	34 - $85.00	35 - $87.50	36 - $90.00
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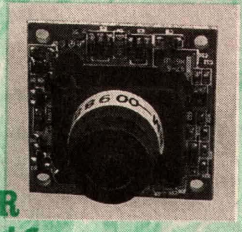

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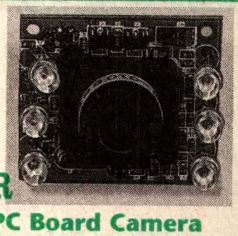

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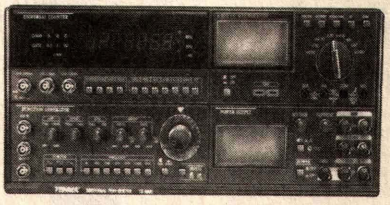

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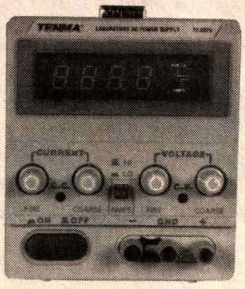

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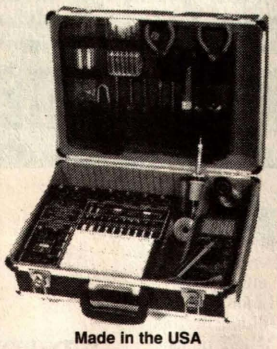

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- Meets UL-1244 safety specs

DIGITAL LCR METER
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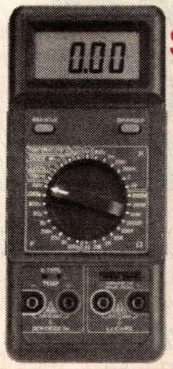

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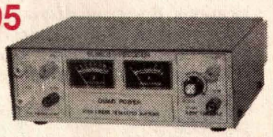

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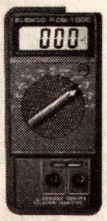

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- Zero adjust
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- 1/2% basic accuracy
- Tilt stand

Digital Audio Generator
with built-in Counter
SG-9300

- 10Hz - 1MHz
- Low Distortion
- Sine/Square waves
- Built-in 150MHz Frequency Counter

$175

SG-9200 Analog/No counter $119.95

Model AM/FM-108K
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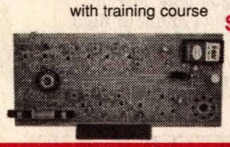

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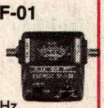

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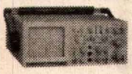

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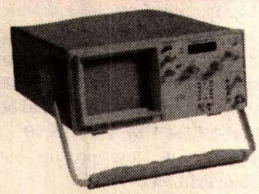

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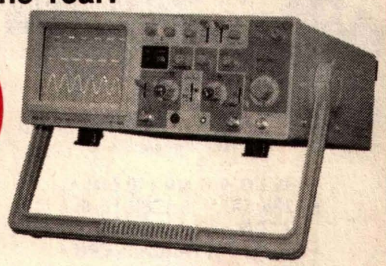

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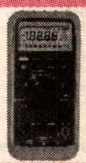

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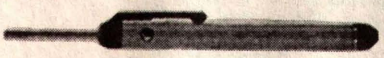

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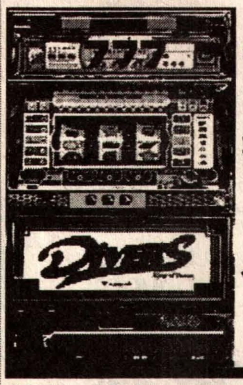

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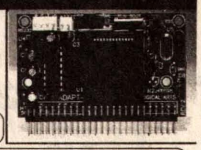

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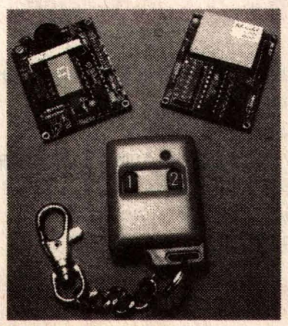

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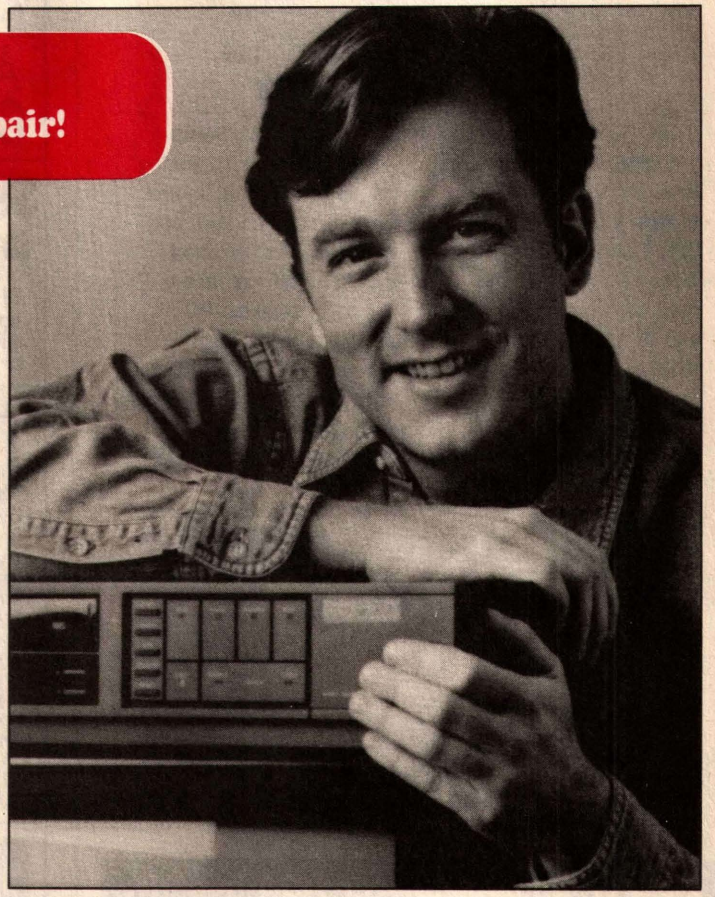

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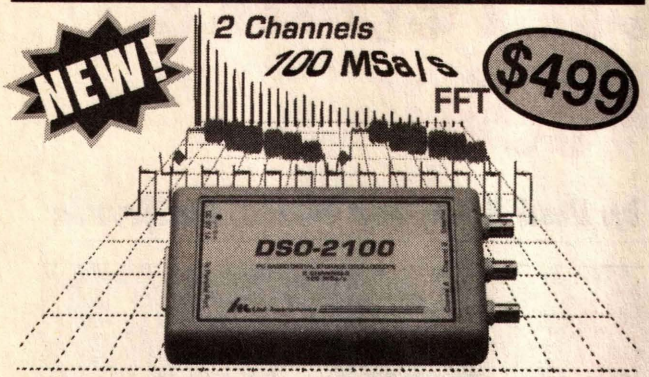

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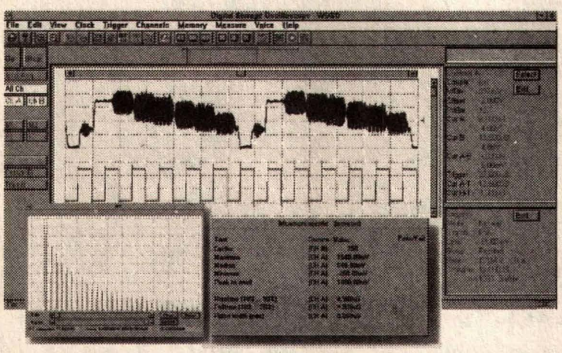

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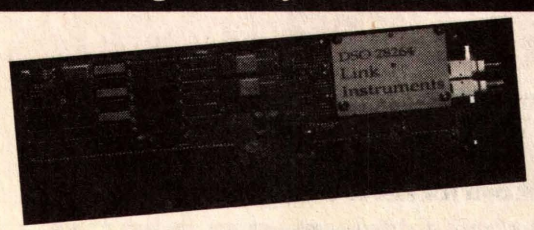

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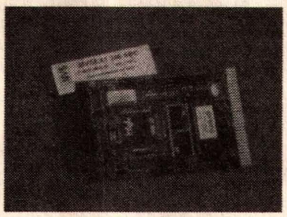

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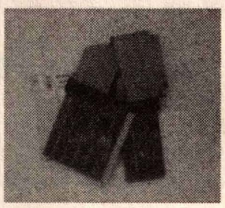

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PROGRAM MEMORY	768 OTP	1K FLASH
MATH REGISTERS	1	32
MAX INSTRUCTIONS / SEC	5M	20M
MAX COUNTER BITS	16	18
INPUT / OUTPUT BITS	12	15
A TO D COMPARATOR	NO	YES
HARDWARE INTERRUPTS	NONE	3

PINOUT:

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PD0	2	19	PB7
PD1	3	18	PB6
XOUT	4	17	PB5
XIN	5	16	PB4
PD2/INT	6	15	PB3
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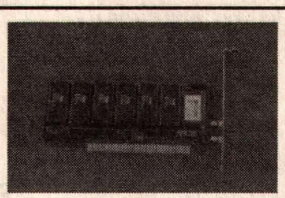

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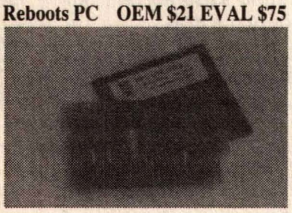

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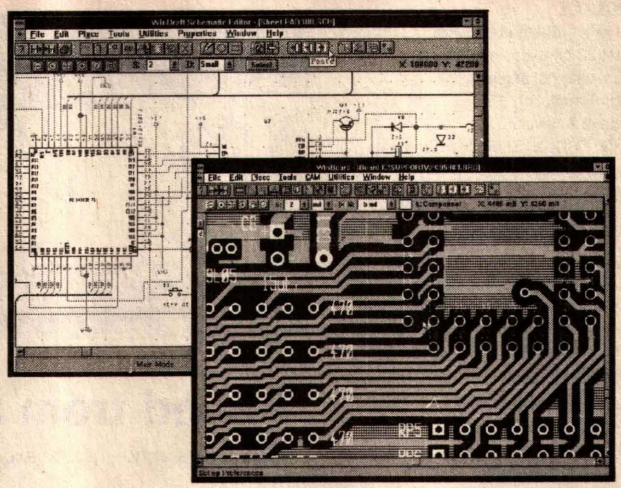

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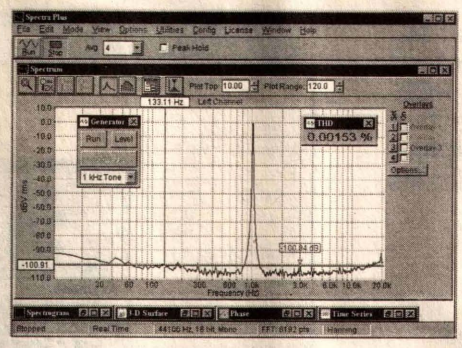

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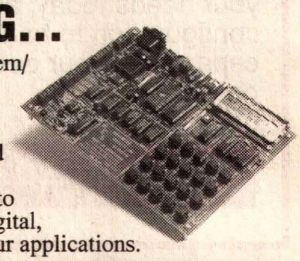

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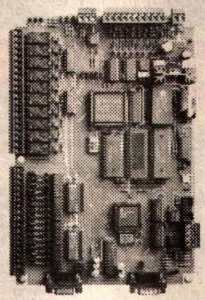

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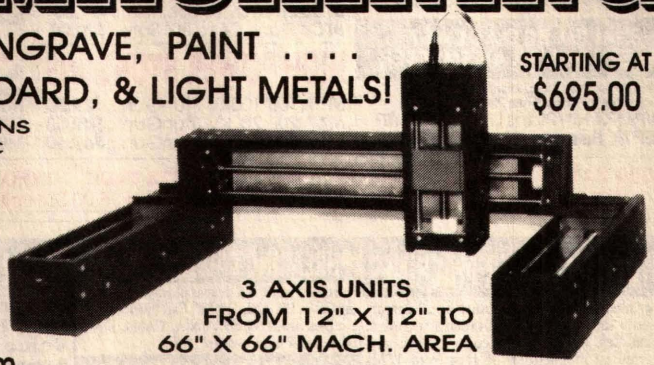

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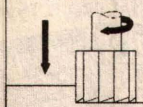

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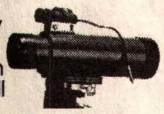

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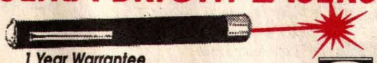

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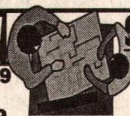

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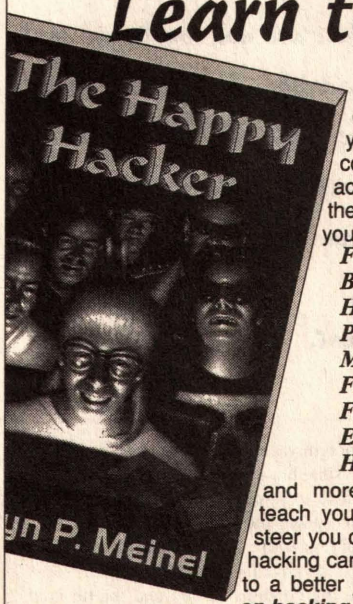

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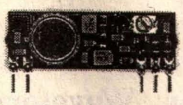

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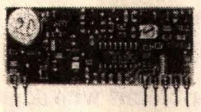

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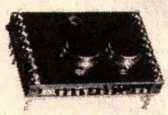

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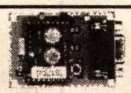

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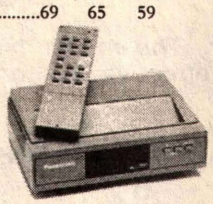

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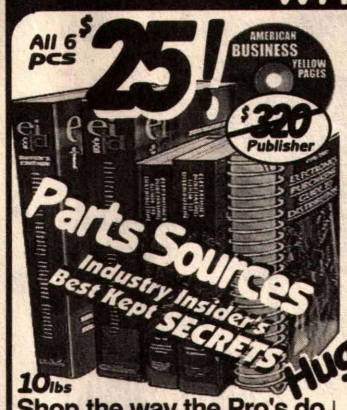

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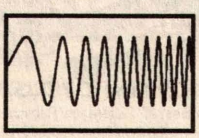

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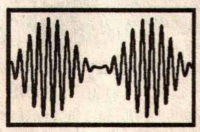

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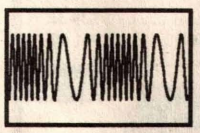

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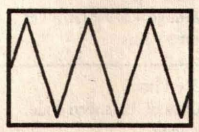

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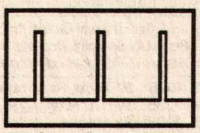

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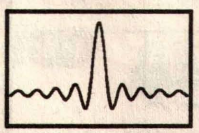

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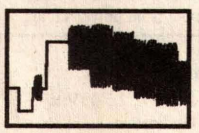

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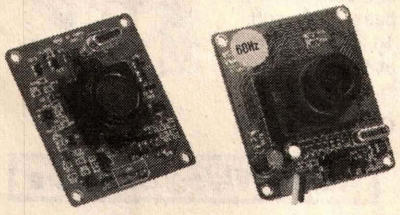

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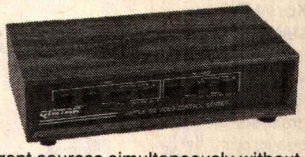
277-035	MDT-39	46.50	45.50
277-040	MDT-40	58.50	56.50

Amplified Video Switching Center



High quality video switching center gives you the flexibility to watch and/or record different sources simultaneously without the need to move complicated cables. Connect your VCR, CATV, satellite, video game, or home computer to two television sets. Gives you total control of your video system. 4 inputs, 2 outputs, all connections via "F" connectors. Pushbutton design. Amplified, broadband circuitry minimizes signal loss and crossover. Simulated wood grain cabinet. Net weight: 4 lbs.

#180-155 ..... **$42.90**(1-3) **$38.50**(4-UP)

FLUKE®
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Part #	Model	Price
392-042	77-III	$174.75
392-026	70-III	96.50
392-032	73-III	125.95
392-036	75-III	154.80
392-038	26-III	213.50
392-046	79-III	193.80

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Part #	Description	Price (1-3)	Price (4-UP)
297-210	8 Ohm, 15W-75, 5-1/4"	$127.50	$119.90
297-215	4 Ohm, 15W-75, 5-1/4"	127.50	119.90
297-230	8 Ohm, 17W-LQ, 6-1/2"	131.90	125.95
297-235	4 Ohm, 17W-LQ, 6-1/2"	131.90	125.95
297-240	8 Ohm, 20W-75, 7-1/2"	145.90	139.90
297-245	4 Ohm, 20W-75, 7-1/2"	145.90	139.90

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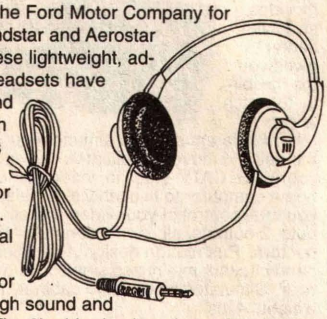
Great Sounding! KOSS DIGITAL Stereo Headphones

Koss MAC-5
Made for the Ford Motor Company for use in Windstar and Aerostar Vans. These lightweight, adjustable headsets have great sound quality with great bass response for home or studio use. Supra-Aural foam ear cushions for hear-through sound and comfort. The 8' rubberized cords are terminated with 3.5 mm stereo phone plugs. Frequency response: 20-20,000 HZ.



$12.50 each — CAT #HP-5 — 10 for $100.00

SPECIAL LOW PRICING Automotive Multi-Voltage Adaptor

Sanbor M-24
Regulated DC converter plugs into car cigarette lighter and provides power for portable audio and communications devices and many battery operated devices that operate on 500 ma or less. Voltage selector switch for 1.5, 3, 4.5, 6, 7.5 and 9 volts. Polarity switch. Six varieties of output plug including, 2.1, 2.5 and 1.3 mm co-ax power plugs, 2.5 and 3.5 mm phone plugs and 9 volt battery snap.

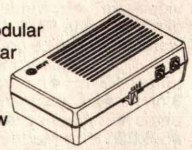
$2.00 each — CAT #APC-522 — 10 for $15.00

High Grade Stereo VIDEO/AUDIO DUBBING CABLE

75 ohm video cable with two audio cables for stereo dubbing. Heavy-duty gold plated metal RCA plugs with spring-steel strain reliefs. Black cord 5 foot long
CAT # AVS-60 — $5.00 each

Dual-Tone TELEPHONE EXTENSION RINGER

AT&T# 24060
Plugs into any standard modular phone outlet so you can hear the phone from wherever you are. Allows you to select "real" bell, high or low electronic tone or turn it off all together. 6" X 3.55" X 1.62" beige case. Includes modular cord and double-sided tape for attachment to wall or cabinet.



CAT# FR-24060 — $8.50 each

410 uf, 300 Volt Photoflash Capacitor

Rubycon # 1A2304A
0.7" diameter X 1.7" long. Right angle PC or solder leads on 0.25" centers.
CAT # PPC-410 — $2.00 each
10 for $18.50 • 200 for $320.00

Filtered Modular Jack

Corcom # RJ11B-4L-B
"Signal Sentry™"
4 pin, RJ-11 modular jack with built-in ferrite block for inductive filtering. 0.52" x 0.8" x 0.59" high. UL, CSA. Large quantity available.

CAT # MT-4F — $1.25 each
10 for $10.00 • 100 for $85.00

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PAINFULLY BRIGHT RED LED
2500 to 4000 mcd @ 20 ma. These T 1 3/4 (5 mm diameter) red LEDs are significantly brighter than conventional LEDs. At close range, they are painful to look at. They are great for attention getting displays that can be seen from a distance. Water clear in off-state.

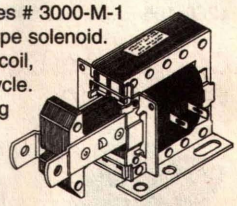
CAT # LED-42
2 for $1.20
10 for $5.00
100 for $45.00
1000 for $400.00

BLUE LED

High Brightness - T 1 3/4 (5mm) point source BLUE LED. Water clear in off state.
$2.75 each — CAT # LED-45 — 10 for $22.50

120 VAC SOLENOID

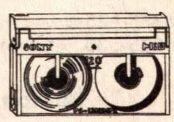
Dormeyer Industries # 3000-M-1
Heavy-duty, pull-type solenoid. 120 Vac, 6.2 ohm coil, continuous duty cycle. 3" x 2.36" mounting base. 2.95" high. 16 lbs pull force at 1". Maximum stroke, 1.25".



CAT # SOL-51 — $9.00 each

"HI-8" Video Cassette

SONY Hi-8 Top quality, metal particle 120 minute video cassettes. *Used for a short time, then bulk-erased.* Each cassette has its own plastic storage box.



CAT # VCU-8 — $3.00 each
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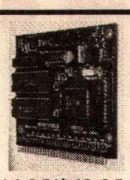

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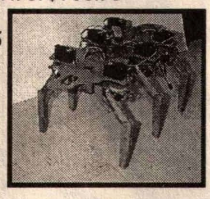

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• Communications Boards •

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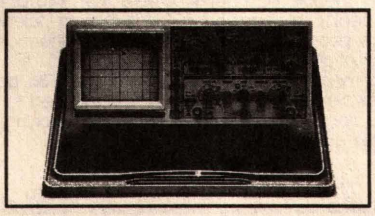

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$19.00 any qty

General

Display: 3-1/2 Digit LCD, 21mm Figure Height with Automatic Polarity
Overrange Indication: 3 Least Significant Digits Blank
Temperature for Guaranteed Accuracy: 23°C±5°CRH<75%
Temperature Ranges: Operating: 0°C to 40°C (32°F to 104°F) Storage: -10°C to 50°C (14°F to 122°F)
Power: 9V Alkaline or Carbon-Zinc Battery(NEDA1604)
Low Battery Indication: BAT on Left of LCD Display
Dimensions: 188mm long x 87mm wide x 33mm thick
Net Weight: 400g

DC Voltage (DCV)

Range:	Resolution:	Accuracy:
200mV	100µV	
2000mV	1mV	±(1%rdg+2dgts)
20V	10mV	
200V	100mV	
1000V	1V	

Maximum Allowable Input: 1000V DC or Peak AC.

DC Current (DCA)

Range:	Resolution:	Accuracy:
200µA	100nA	
2000µA	1µA	±(1.2%rdg+2dgts)
20mA	10µA	
200mA	100µA	±(1.2%rdg+2dgts)
10A	10mA	

Overload Protection: mA Input. 2A/250V fuse.

Resistance (Ω)

Range:	Resolution:	Accuracy:
200Ω	100mΩ	
2000Ω	1Ω	
20KΩ	10Ω	±(1.2%rdg+2dgts)
200KΩ	100Ω	
2000KΩ	1KΩ	
20MΩ	10KΩ	±(2%rdg+10dgts)

Maximum Open Circuit Voltage: 2.8V

Diode Test

Measures forward voltage drop of a semiconductor junction in mV test current of 1.5mA Max.

ohFE Test

Measures transistor hFE.
Frequency Range: 45Hz-450Hz
Maximum Allowable Input: 750V rms
Response: Average Responding. Calibrated in rms of a Sine Wave.

AC Voltage (ACV)

Range:	Resolution:	Accuracy:
200V	100mV	±(1.2%rdg+10dgts)
750V	1V	

CAT NO	DESCRIPTION	PRICE
9300G	Rugged High Quality DMM with Rubber Boot	$19.00

Positive Photofabrication Kit

Make your own PCB's

Kit includes the basic items needed to fabricate pre-sensitized printed circuit boards (does not include artwork). Also included is a basic process guide to assist the user in the basics of exposing, developing and etching a PCB. All items fit conveniently in the plastic development tray, and a tight fitting lid is included for handy storage. Additional recommended supplies for fabricating PCB's are: exposure bulb, etchant tank, eye protection, art-work, paper towels.

Kit Includes

- 1 each 3"x5" pre-sensitized single sided PCB
- 1 each 4"x6" pre-sensitized single sided PCB
- 1 each 6"x6" pre-sensitized single sided PCB
- 1 each 500ml developer liquid
- 1 each 500ml ferric chloride etching liquid
- 2 each foam brushes
- 1 each plastic development tray
- 1 each rubber gloves
- 1 each instruction sheet

new!

CAT NO	DESCRIPTION	PRICE
416-K	Photofabrication Kit	$27.95

Positive Photo Resist Pre-Sensitized Printed Circuit Boards

These pre-sensitized printed circuit boards are ideal for small production runs. They provide high resolution and excellent line width control. High sensitive positive resist coated on 1oz. copper foil allows you to go direct from your computer plot or art work layout. No need to reverse art.

Single-Sided, 1oz. Copper Foil on Paper Phenolic Substrate

CAT NO	DESCRIPTION	1	PRICE EACH 10	50
PP101	100mm x 150mm/3.91" x 5.91"	$2.55	$1.90	$1.70
PP114	114mm x 165mm/4.6" x 6.6"	2.98	2.45	1.98
PP152	150mm x 250mm/5.91" x 9.84"	5.40	3.98	3.60
PP153	150mm x 300mm/5.91" x 11.81"	6.15	4.48	4.10
PP1212	305mm x 305mm/12" x 12"	12.78	10.65	8.52

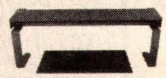
Single-Sided, 1oz. Copper Foil on Fiberglass Substrate

CAT NO	DESCRIPTION	1	PRICE EACH 10	50
GS101	100mm x 150mm/3.91" x 5.91"	$ 3.90	$2.98	$2.60
GS114	114mm x 165mm/4.6" x 6.6"	4.80	3.49	3.20
GS152	150mm x 250mm/5.91" x 9.84"	8.69	5.98	5.78
GS153	150mm x 300mm/5.91" x 11.81"	10.20	7.20	6.80
GS1212	305mm x 305mm/12" x 12"	18.88	15.73	12.59

Double-Sided, 1oz. Copper Foil on Fiberglass Substrate

CAT NO	DESCRIPTION	1	PRICE EACH 10	50
GD101	100mm x 150mm/3.91" x 5.91"	$ 5.07	$3.68	$3.38
GD114	114mm x 165mm/4.6" x 6.6"	5.95	4.29	3.99
GD152	150mm x 250mm/5.91" x 9.84"	10.47	7.39	6.98
GD153	150mm x 300mm/5.91" x 11.81"	11.95	8.69	8.30
GD1212	305mm x 305mm/12" x 12"	22.09	18.35	14.68

Exposure System



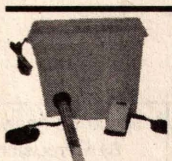
Just place your presensitized board and artwork centered under the exposure fixture. Place the convenient acrylic sheet over the board and artwork to hold everything in place. Turn on light. Voila! Exposure takes about 5 minutes. Kit includes one fluorescent tube, stand and acrylic weight.

new!

Features

- Exposes boards in about 5 minutes!
- Convenient acrylic sheet to hold board in place during exposure (12.5" x 8.5")
- Fluorescent light fixture with plastic cover designed to aid in proper light refractions for even exposure

CAT NO	DESCRIPTION	PRICE
416-X	Fluorescent Exposure System	$31.95
416-B	Extra Replacement Fluorescent Tube	16.95

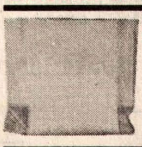


Etching Tank

This handy etching system will handle PC boards up to 8" x 9", two at a time. Ideal for etching your PCB's! System includes an air pump for etchant agitation, a thermostatically controlled heater for keeping etchant at optimum temperature and a tank that holds 1.35 gallons of etchant. A tight fitting lid is also supplied to prevent evaporation when system is not being used. Typical etching time is reduced to 4 minutes on 1oz. copper board!

REDUCES ETCHING TIME!

CAT NO	DESCRIPTION	PRICE
12-700	Etch Tank System	$37.95



Developer

This product is used as the developer on our positive photo-resist printed circuit boards. Includes instructions. 50 gram package, mixes with water, makes 1 quart.

CAT NO	DESCRIPTION	PRICE EACH 1	10	25
POSDEV	Positive Developer	$.95	$.80	$.50

Etching Chemicals/Ferric Chloride

A dry concentrate that mixes with water to make 1 pint of etchant, enough to etch 400 sq. inches of 1oz board.

CAT NO	DESCRIPTION	PRICE EACH 1	5
ER-3	Makes 1 pint	$3.50	$2.75

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Color Weather Proof Bullet Camera

1/3" CCD with removeable rotation capable mounting bracket

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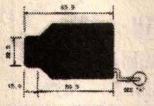

Specifications

Image Sensor:	Interline transfer CCD 1/3" format
Effective Pixel:	512(H)x492(V) pixels/NTSC 512(H)x582(V) pixels/PAL
Scanning System:	2 : 1 interlaced
Sync System:	Internal sync
Sync Pulse:	15.734KHz +1%(H)/15.625KHz +1%(H) 59.94Hz +1%(V)/ 50Hz +1%(V) Sub-Carrier 3.57 MHz +30ppm
Resolution:	400 TV lines (H)
S/N Ratio:	More than 46dB (typ)
Gamma Characteristics:	0.45
Min. Illumination:	1 LUX (F1.2 10 IRE)
Video Out:	Composite video signal : 1.0Vp-p
White Balance:	Auto white balance
Electronic Shutter:	1/60 - 1/100,000 SEC(N) 1/50 - 1/100,000 SEC (P)
Power Supply:	DC 12V + 10%
Power Consumption:	240mA (typ)
Lens:	4mm (78 or 92 degree) F : 2.0
Ambient Operating Temp:	-5 deg. C +40 Deg. C
Ambient Storage Temp:	-10 Deg. C+50 Deg. C RH 95% MAX
Dimension:	2 1/8" (L) x 1 1/4" (D)
Weight:	3 oz.

CAT NO	DESCRIPTION	PRICE EACH 1	5
WDB-5407S	Color Water Tight Bullet Camera	$299.00	$269.00

(water tight for outdoor use, not suitable for sustained underwater use)

CCD Bullet Cameras

new!

Available with standard or pinhole lens. Virtually indestructible bullet shaped casing. This sleek B&W camera can be mounted on walls or ceilings along narrow corridors or virtually any location for virtually any surveillance application. 0.5 lux minimum illumination with 380 lines of resolution. Even includes a built-in electronic iris for automatic light compensation.

Features

- Extremely low power consumption
- No blooming, no burning
- 0.5 LUX minimum illumination
- CCD area image sensor for long camera life
- Ultra small size allows for simple application and installation
- Built-in electronic auto iris for automatic light compensation
- Ultra compact camera

Specifications

Image Pick-Up Device:	1/3" CCD area sensor
No. of Pixels:	EIA = 512(H) x 492(V)
Pixel Pitch:	EIA = 9.6uM(H) x 7.5uM
Scanning System:	EIA=525 lines, 60 field/sec
Sync System:	Internal sync
H. Resolution:	430 TU line
V. Resolution:	400 TU line
Usable Illumination:	0.5 Lux F1.6
S/N Ratio:	More than 48dB
Gamma Characteristic:	0.45
Video Output:	1.0 - 1.1 up-p 75 Ohm
Electronic Shutter Time:	EIA=1/60 - 1/50,000 sec
Lens F No. Focal Length:	STD : 1.6 Open / 4.3mm(78 deg) Pinhole: 4.3 fixed/ 2.8mm(91.4 deg)
Power Consumption:	DC 9V (8-10V), 110mA
Operational Temp.:	-10 deg - +50 deg C RH95% max
Storage Temp:	-20 deg - +60 deg C RH95% max
Dimensions:	STD : 22mm(W) x 22mm(H) x 38mm(D) Pinhole: 22mm(W) x 22mm(H) x 30mm(D)
Weight:	35g max

CAT NO	DESCRIPTION	PRICE EACH 1	5
WDB-07S	Standard Lens Version	$144.00	$129.00
WDB-07P	Pinhole Lens Version	144.00	129.00
WDP-07S/water	Standard Lens Weather Proof	169.00	152.00
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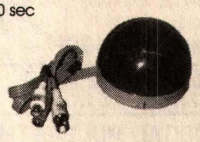

Specifications

Image Device:	1/3" interline transfer CCD
Picture Elements:	EIA=542(H)x492(V)
Scanning System:	2:1 Interlace
Synchronization System:	Internal
Horizontal Resolution:	380 TV Lines
Sensitivity:	Under 0.3 LUX
Electronic Iris (linear):	EIA = 1/60~1/100,000 sec
Video Output:	1.0vp-p, 75 ohm
S/N Ratio:	More than 50dB
Power Supply:	12V DC (±20%)
Gamma:	r=1
Power Consumption:	110 mA max
Operating Temp.:	-10°C ~ +50° C
Operating Humidity:	RH 95% Max
Weight:	100g
Applied Lens:	3.6mm -92°, 4.3mm -78°
AI/EE/Flicker Less/Mirror Image:	Jump soldering selection
Audio Pick-up Sensitivity:	-60dB (0dB=1V/ubar)
Audio Frequency Range:	20 Hz ~ 20 kHz
Audio S/N Ratio:	More than 40dB
Audio Output Level:	1Vp-p/600 ohm
Dimensions:	87 x 55.5mm

CAT NO	DESCRIPTION	PRICE EACH 1	5
WDDB-6500	B&W Dome Camera	$144.00	$129.00

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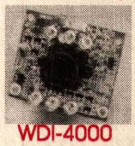
WDP-2000

WDS-2005



WDI-4000

Specifications

Image Pick-Up Device	1/3" CCD area Sensor
Picture Elements	EIA=512(H) x 492(V)
Pixel Pitch	EIA=9.6UM (H) x 7.5UM (V)
Scanning System	2 : 1 interlace
Scanning Frequency	EIA=525 lines, 60 field/sec (II) 15.750 KHz x 60 HK
Resolution	430 Lines
Minimum Illumination	0.03 LUX
S/N Ratio	45DB
Lens Mounting	4.3mm standard, 5mm pinhole
Video Output	1.0 VP-P/750OHM composite signal
Power Requirement	8-12 VDC (9VDC standard)
Power Consumption	100mA
Operating Temperature	-20C -+ 70 C RH 95% Max
Storage Temperature	-40C -= 85 C RH 95% Max
Audio Pick-Up Sensitivity	-60 DB (0DB = 1B/UBAR. 1KNZ)
Audio Frequency Range	20 Hz to 20KHz
Audio S/N Ratio	More than 35DB
Audio Output Level	1VP-P/600 OHM

Dimensions

WDP-2000	30mm (H) x 30mm (W)
WDS-2005	30mm (H) x 30mm (W)
WDI-4000	44mm (H) x 30mm (W)

CAT NO	DESCRIPTION	PRICE EACH 1	5
WDP-2000	1/3" B&W Pinhole Lens with Audio	$89.00	$77.00
WDS-2005	1/3" B&W Standard Lens with Audio	89.00	77.00
WDI-4000	1/3" B&W Infra-RED with Audio	89.00	77.00
WDPH-55BW	Plastic Housing Option for B&W Board Cameras (WDP-2000 & WDS-2005 ONLY)	13.00	12.00

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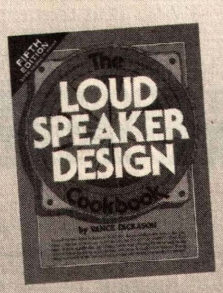

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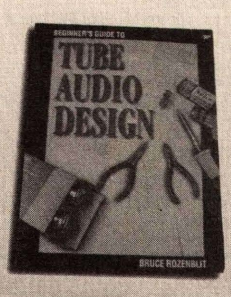

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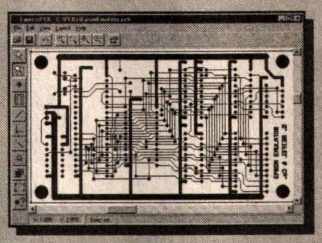

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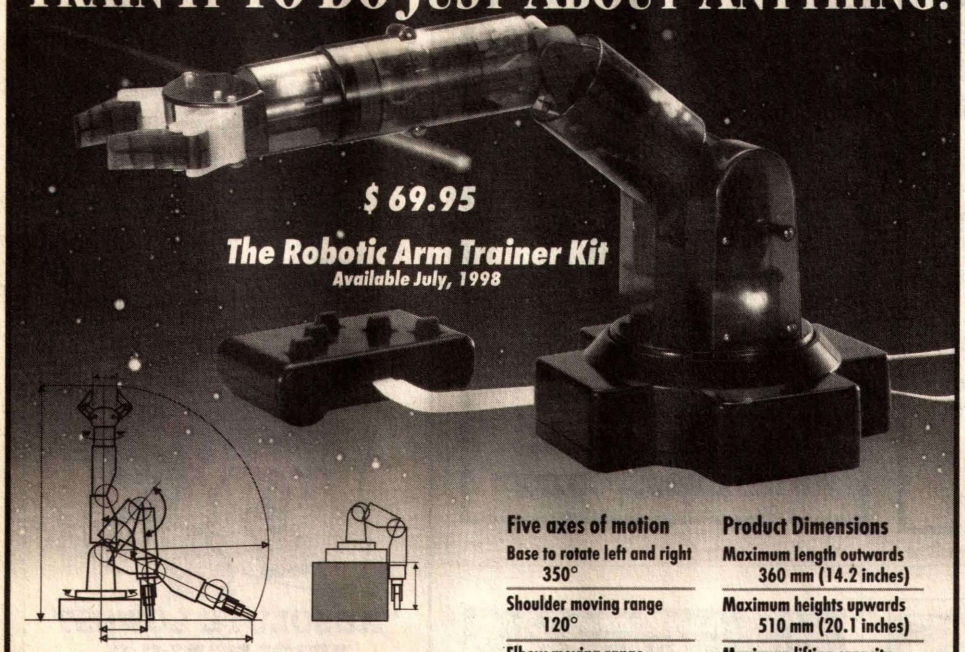

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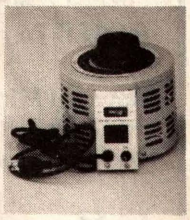

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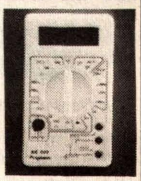

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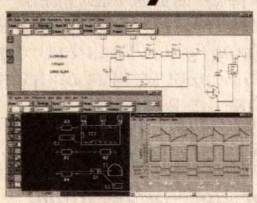

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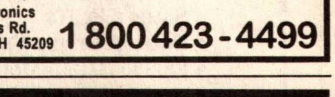

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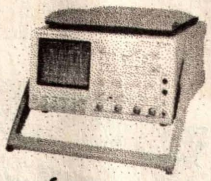

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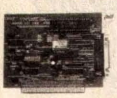

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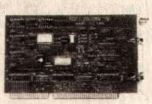

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LPA-1, Power Booster Amplifier Kit.....$39.95
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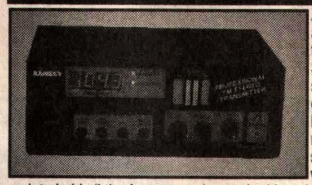

A truly professional frequency synthesized FM Stereo transmitter station in one easy to use, handsome cabinet. Most radio stations require a whole equipment rack to hold all the features we've packed into the FM-100. Set frequency easily with the Up/Down freq buttons and the big LED digital display. Plus there's input low pass filtering that gives great sound no matter what the source (no more squeals or swishing sounds from cheap CD player inputs!) Peak limiters for maximum 'punch' in your audio - without over modulation, LED bargraph meters for easy setting of audio levels and a built-in mixer with mike and line level inputs. Churches, drive-ins, schools and colleges find the FM-100 to be the answer to their transmitting needs, you will too. No one offers all these features at this price! Kit includes cabinet, whip antenna and 120 VAC supply.

We also offer a high power export version of the FM-100 that's fully assembled with one watt of RF power, for miles of program coverage. The export version can only be shipped outside the USA, or within the US if accompanied by a signed statement that the unit will be exported.

FM-100, Professional FM Stereo Transmitter Kit.....$299.95
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AM Band Radio Transmitter

Ramsey AM radio transmitters operate in the standard AM broadcast band and are easily set to any clear channel in your area. Our AM-25, 'pro' version, fully synthesized transmitter features easy frequency setting DIP switches for stable, no-drift frequency control, while being jumper setable for higher power output where regulations allow. The entry-level AM-1 uses a tunable transmit oscillator and runs the maximum 100 milliwatts of power. No FCC license is required, expected range is up to 1/4 mile depending upon antenna and conditions. Transmitters accept standard line-level inputs from tape decks, CD players or mike mixers, and run on 12 volts DC. The Pro AM-25 comes complete with AC power adapter, matching case set and bottom loaded wire antenna. Our entry-level AM-1 has an available matching case and knob set for a finished, professional look.

AM-25 Professional AM Transmitter Kit.....$129.95
AM-1 Entry level AM Radio Transmitter Kit.....$29.95
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Tone-Grabber Touch Tone Decoder / Reader

Dialed phone numbers, repeater codes, control codes, anywhere touch-tones are used, your TG-1 will decode and store any number it hears. A simple hook-up to any radio speaker or phone line is all that is required, and since the TG-1 uses a central office quality decoder and microprocessor, it will decode digits at virtually any speed! A 256 digit non-volatile memory stores numbers for 100 years - even with the power turned off, and an 8 digit LED display allows you to scroll through anywhere in memory. To make it easy to pick out numbers and codes, a dash is inserted between any group or set of numbers that were decoded more than 2 seconds apart. The TG-1 runs from any 7 to 15 volt DC power source and is both voltage regulated and crystal controlled for the ultimate in stability. For stand-alone use add our matching case set for a clean, professionally finished project. We have a TG-1 connected up here at the Ramsey factory on the FM radio. It's fun to see the phone numbers that are dialed on the morning radio show! Although the TG-1 requires less than an evening to assemble (and is fun to build, too!), we offer the TG-1 fully wired and tested in matching case for a special price.

TG-1, Tone Grabber Kit.....$99.95
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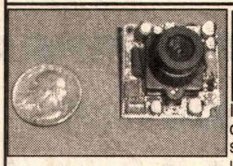
C-2000 Video Transmitter Cube.....$89.95
C-3000 Video and Audio Transmitter Cube.....$149.95

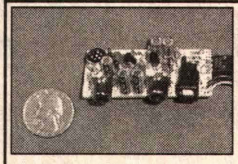
CCD Video Cameras



If you're looking for a good quality CCD board camera, stop right here! Our cameras use top quality Japanese Class 'A' CCD arrays, not the off-spec arrays that are found on many other cameras. You see, the Japanese suppliers grade the CCDs at manufacture and some manufacturers end up with the off-grade chips due to either cost constraints or lack of buying 'clout'. These cameras have nice clean fields and excellent light sensitivity, you'll really see the difference, and if you want to see in the dark, these are super IR (Infra-Red) sensitive! Available with Wide-angle (80°) or super slim Pin-hole style lens. Both run on 9 VDC and produce standard 1 volt p-p video. Add one of our transmitter units for wireless transmission to any TV set, or add our Interface board (below) for Audio sound pick-up and direct wire connection to any Video monitor or TV video/audio input jacks. Fully assembled.

CCDWA-2 CCD Camera, wide-angle lens.....$99.95
CCDPH-2 CCD Camera, slim fit pin-hole lens.....$99.95
IR-1 IR Illuminator Kit.....$24.95

CCD Camera Interface Board



Here's a nifty little kit that eases hook-up of your CCD camera module to any video monitor, VCR or video input TV set. The board provides a voltage regulated and filtered source to power the camera (CCD Cameras require a stable source of power for best operation), sensitive electret condensor mike for great sound pick-up and RCA Phono jacks for both audio and video outputs. Runs on 11 - 20 VDC.

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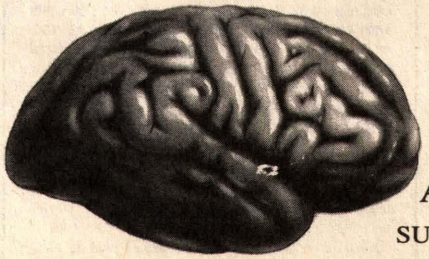

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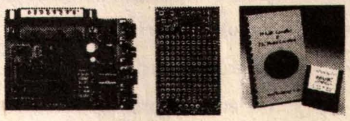

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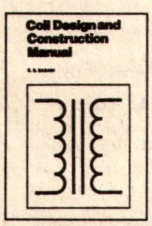

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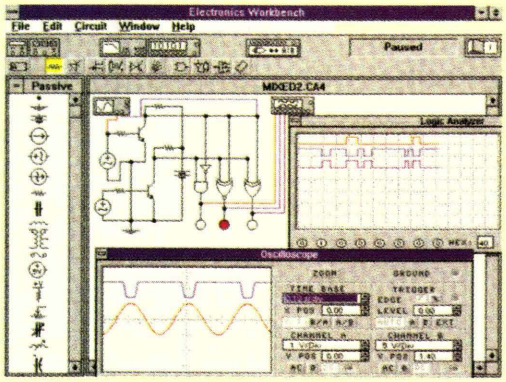

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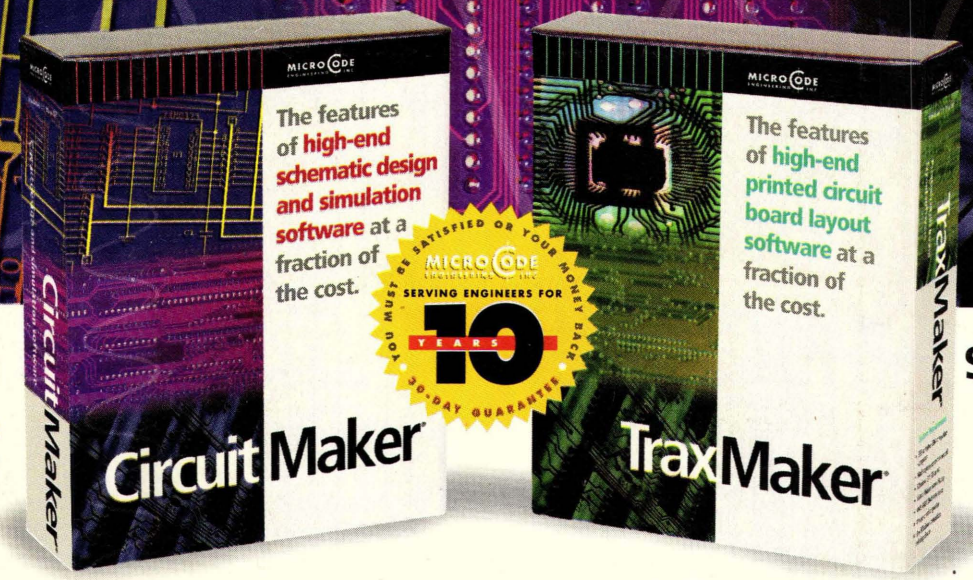
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